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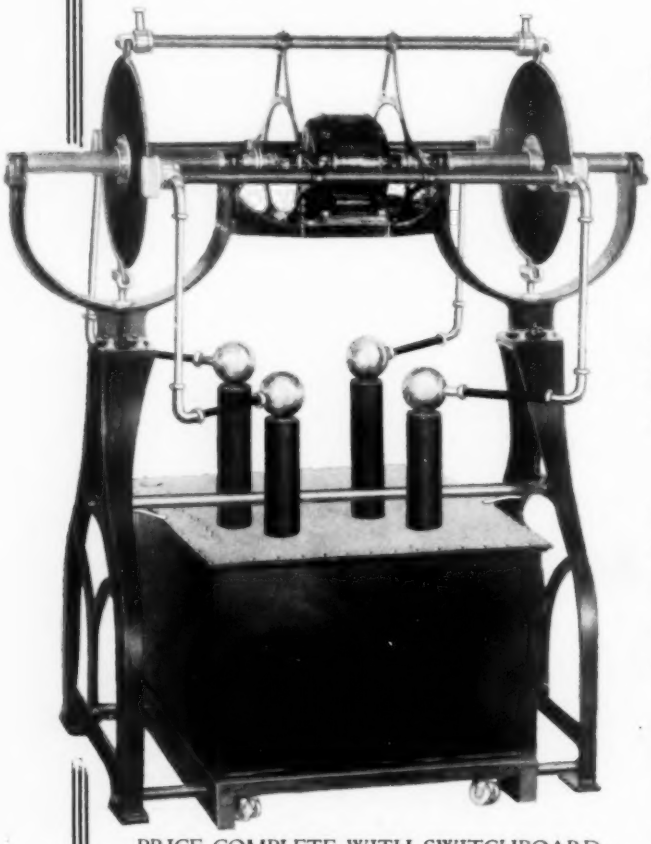

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XI APRIL, 1924 No. 4

THE STUDY OF THE STERNUM BY THE ROENTGEN RAYS*

BY G. E. PFAHLER, M.D.

PHILADELPHIA, PENNSYLVANIA

THE study of the sternum, I believe, has been more or less neglected. More will be known of its diseases when roentgenologists investigate the sternum more or less routinely, especially when there is the slightest suspicion or possibility of its being diseased. Since my interest in this subject has been aroused, I have found metastatic carcinoma of the sternum, secondary to carcinoma of the breast, not uncommon.

Metastatic Carcinoma. One should investigate the sternum in all cases of carcinoma of the breast when the sternum is unusually prominent, especially if the prominence is of recent origin. This study should also be made when there is evidence of mediastinal carcinoma. There may be tenderness and redness, but the patient may have extensive metastatic carcinoma of the sternum and have no subjective symptoms.

The appearances of the sternum when involved by carcinoma are those of carcinoma of bone elsewhere. One finds an irregular decalcification, with no limiting margins of the disease, and no evidence of bone repair (unless there has been roentgen-ray treatment). Of course, if healing can be brought about by roentgen therapy, there will be a redeposit of lime salts and the bone regains a solid or normal appearance.

FIG. 1. Female, married, aged fifty-five. Referred by Drs. Haggert and Blake. Examination Apr. 27, 1922, shows a prominent normal sternum in the case of carcinoma of the breast. Notice the infiltration of the mediastinum.

*Read at the Fifth Annual Meeting, Eastern Section, AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, Jan. 24–26, 1924.

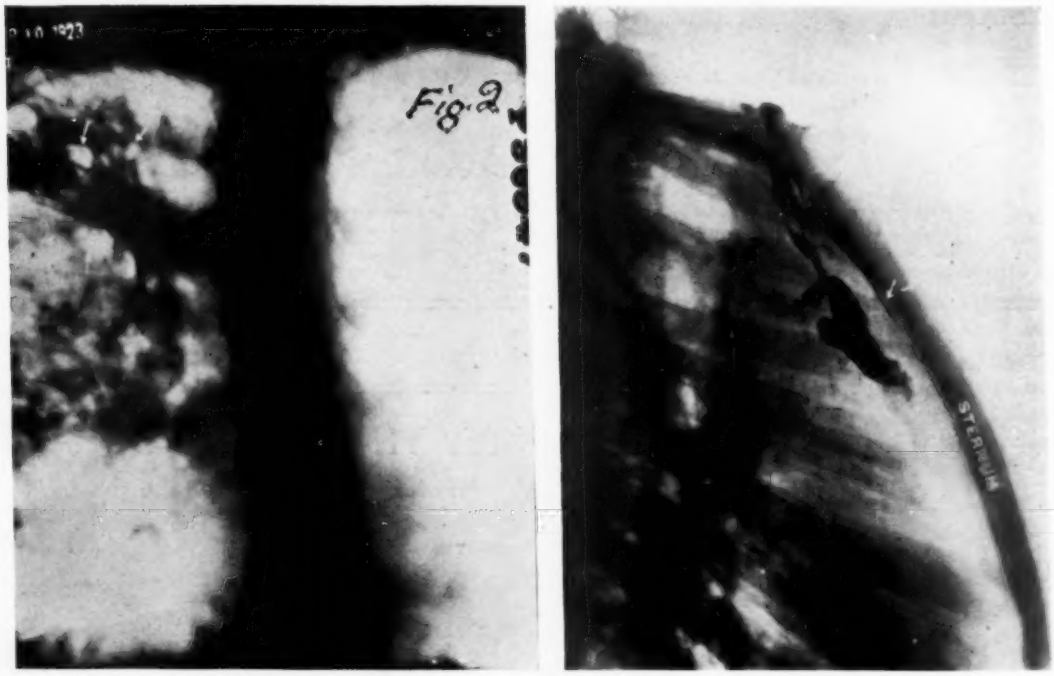

FIG. 2. Male, aged eighteen. Referred by Dr. Kirby, Sept. 10, 1923; having a sinus draining through the suprasternal notch, sinus injected by bismuth paste. Patient has pulmonary tuberculosis and tuberculosis of the sternum and mediastinum.

Tuberculosis of the sternum will present a similar appearance to tuberculosis of the bone elsewhere and consists of a local absorption of lime salts, with an adjacent general bone atrophy. In the cases that I have seen the disease was a direct extension from tuberculosis in the adjacent tissues.

Pressure necrosis may result from the pressure of a mediastinal tumor, especially if such a tumor is of a benign character. It may also result from the pressure of an aneurysm.

Necrosis from pressure will be indicated by a more homogeneous decalcification or thinning of the bone, with no evidence of invasion, and localized to the pressure area of the underlying tumor. The underlying tumor, of course, can always be demonstrated by roentgenoscopy and roentgenography. The interpretation is always aided by the study of the associated signs and symptoms.

Traumatism resulting in fractures or perforating wounds will, by its history and nature, generally suggest the sternal involvement, and the appearances will be similar to those of corresponding lesions in other bones.

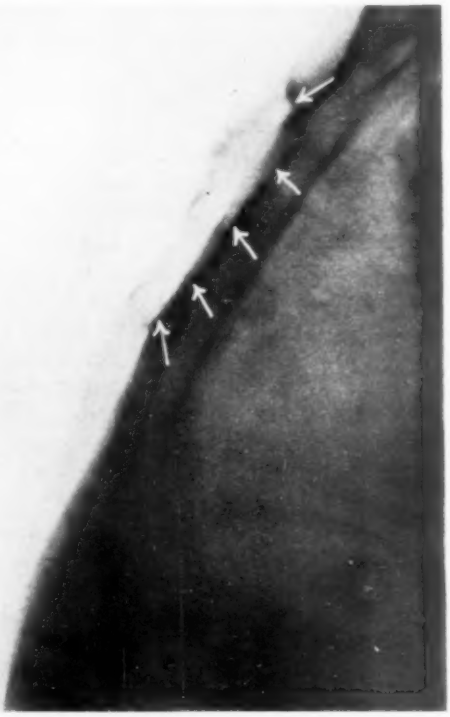

FIG. 3. Female, aged seventy-seven. Referred by Dr. Mair. Examination Feb. 19, 1923. Patient has had a tuberculous ulcer of the sternum for many years. Notice the erosion of the sternum.

FIG. 4. Male, aged forty-two. Referred by Dr. Russell, Oct. 12, 1922. Suffering from aneurysm of the aorta and innominate, showing erosion of the manubrium.

FIG. 5. Female, married. Referred by Dr Haggert. Examination Feb. 9, 1922, shows mediastinal sarcoma, secondary to sarcoma of the hand; first operated upon twelve years ago; shows mediastinal tumor and sarcoma of the sternum.

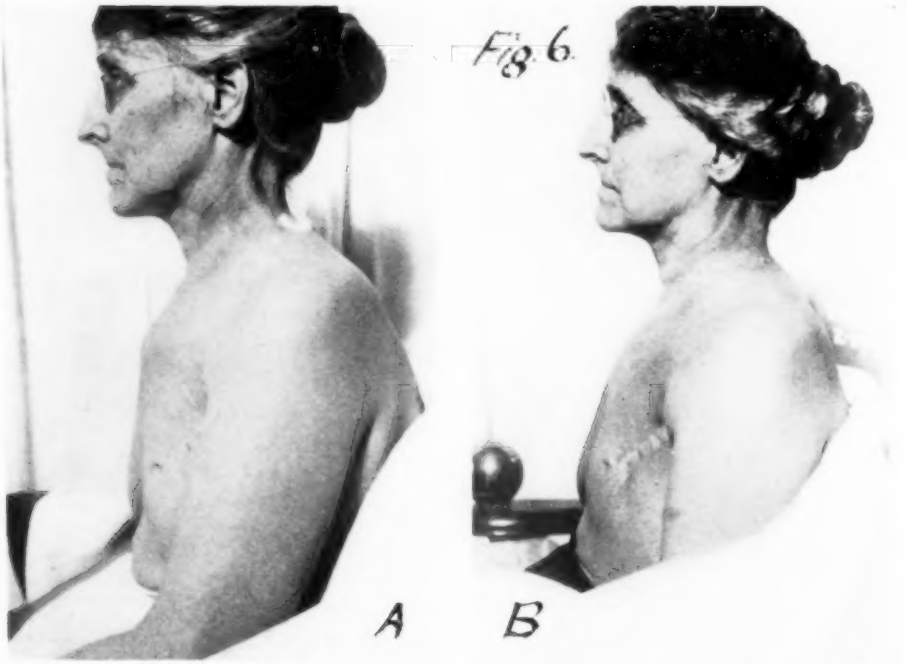

FIG. 6. Female, married, aged fifty-six. Referred by Dr. W. Fritz, Feb. 24, 1922. Mediastinal carcinoma secondary to carcinoma of the breast. A shows bulging of the sternum, May 8, 1921. B shows retraction or healing of the sternum, Feb. 14, 1922.

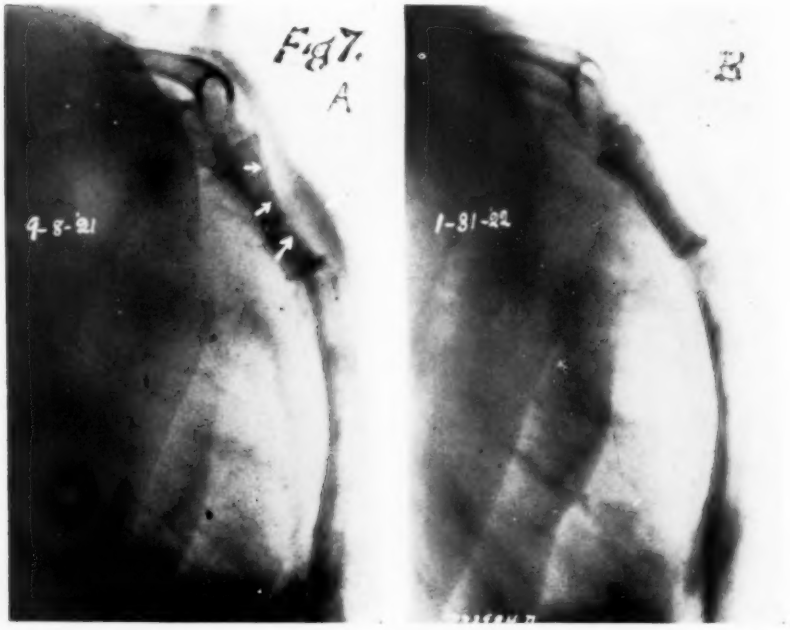

FIG. 7. Female, married, aged fifty-six. A shows a metastatic carcinoma of the sternum, Sept. 8, 1921. B shows healing of the sternum, Jan 31, 1923.

Technique. The usual anteroposterior or posteroanterior positions give no evidence of the sternum because of the dense overlying shadows of the spinal column. This difficulty is not overcome by the use of a Potter-Bucky diaphragm or stereoscopy. The sternum can be demonstrated only by eliminating the shadow of the spinal column. This can be done by three positions, all of which should be used.

It is, of course, necessary that the patient be held perfectly still, either by pressure of his own body against the frame, by having the patient hold firmly with his hands, or by binding him with a compression band.

(3) *The lateral position is probably the most important.* For this, it is also desirable to have the patient stand if possible. Roentgenoscopy is of little value. The

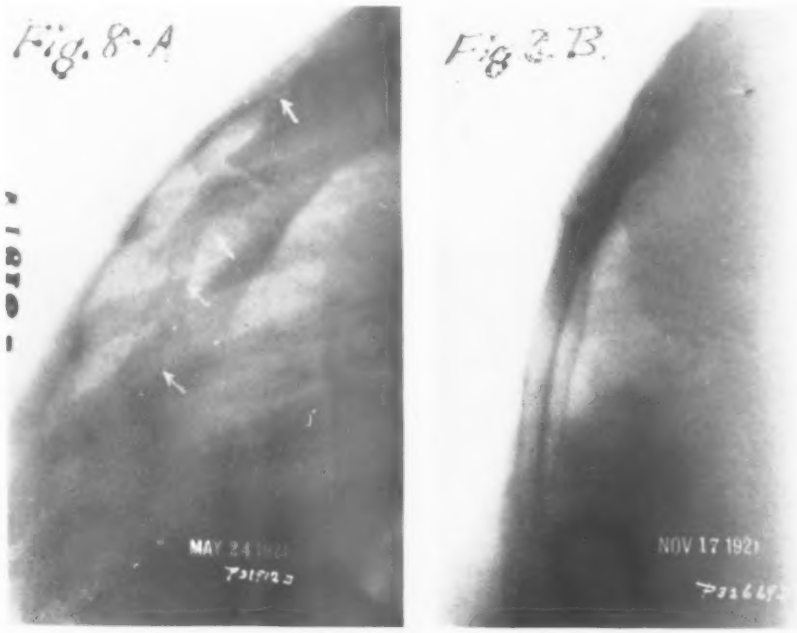

FIG. 8. Female, married, aged forty. Recurrent carcinoma of the breast with metastases in the mediastinum. A shows carcinoma of the sternum, May 24, 1921. B shows the sternum healed under the influence of roentgen-ray treatment, Nov. 17, 1921.

(1) The right oblique position, in which the rays are passed from the left posterior to the right anterior.

(2) The left oblique, which consists in passing the rays from the right posterior to the left anterior.

Both of these positions are best obtained by a preliminary study with the roentgenoscope, rotating the patient until the shadow of the spinal column, heart and aorta are projected away from the sternal shadow as far as is possible. This can be done best with the patient standing. After the exact position has been determined it is desirable to be able to replace the screen with a film or plate, without changing the position of the patient. film is placed in an upright plate holder. The tube is placed at a distance of 40 in. The patient is turned laterally; the hands are placed back of the body, and by means of a compression band the shoulders are forced back as far as possible. This causes the sternum to be projected forward as far as possible. The film is exposed during full inspiration.

A diaphragm or cone is chosen which will exactly cover an 8×10 in. film. We use duplitized, superspeed films with double intensifying screens, $4\frac{1}{2}$ in. parallel spark resistance in a Coolidge tube, and make an exposure of 8 to 12 seconds, with 30 ma. of current. The top of the film is placed on a level with the

upper border of the clavicles. This technique will show the sternum clear of all other tissues. If the three positions are used, any disease of the sternum should be recognized.

ABSTRACT OF DISCUSSION

In answer to questions Dr. Pfahler described the technique for roentgenography of the sternum, as follows: The patient is erect, in a true lateral position and the tube centered over the middle of the sternum at a distance of 40 in. An 8 × 10 in. film and a small cone are used. The exposure factors are 30 ma., 4 to 4½ in. gap, and time 8 to 12 seconds, with double screens and superspeed films. Although the erect position is best, good results may also be obtained with the patient recumbent.

RYAN'S RULE

BY A. HOWARD PIRIE, M.D.

MONTREAL, CANADA

THIS instrument is constructed for convenience in treatment. In appearance it resembles a small telescope which may be reduced to a length of 4¼ in. or extended to a length of 16 in. It is marked every quarter of an inch by figures which represent the time of roentgen-ray dosage. These figures are for use with a 7-in. universal broad-focus Coolidge tube using 8 ma. and an equivalent spark-gap of 6 to 7 in. between blunt points.

To use the instrument the roentgen-ray tube is placed over the part to be treated. The skin target distance is not measured but one end of the telescopic rule is placed on the skin and the telescope is gradually extended until its other end touches the glass of the tube. The last visible number on the telescope represents the number of minutes and seconds required to give an epilation dose without filter under the above conditions.

A second set of numbers on the instrument represents the time for an erythema dose when using a 3 mm. aluminum filter. The instrument is made only to show the epilation dose and the surface erythema dose. The latter is a small dose which may be repeated each month for six months, producing intense browning at the end of that time.

In order to secure the figures placed upon the rule, I treated all my ringworm cases at a focus skin distance of 9 in. and uniformly obtained perfect epilation and a perfect regrowth of hair by using 8 ma. and 6 to 7 in. equivalent spark-gap for seventy seconds. Having established this to my satisfaction, I calculated the other figures by the inverse square of the distance law and found that they were correct in practice. The erythema dose was similarly established.

NEWER PHASES IN THE ROENTGEN INTERPRETATION OF DUODENAL ULCER*

BY JOSEPH S. DIAMOND, M.D.

NEW YORK CITY

BARELY a decade has passed since Cole [1,2,3,4] first reported his studies on the duodenal defect by means of serial roentgenography. His work made the diagnosis of post-pyloric or duodenal ulcer possible in a larger percentage of cases and helped to establish the validity of the direct method of roentgen diagnosis.

The indirect method of roentgen diagnosis in gastric and duodenal lesions which had its origin on the continent of Europe and is at the present time still in vogue in this country, has failed to supply even its staunchest adherents with more than presumptive evidence. Only the late manifestations met with in stenosis, such as, gastrectasia, with intermittent deep gastric peristalsis and retention can be regarded as immutable evidence of an organic lesion. This disturbed physiology is but an end result. The early symptom-group of rapid motility, exaggerated peristalsis and increased tone, are common to many conditions and are dependent upon the increased irritability of the autonomic nervous system. They are present in simple vagotonia, in the psychoneurotic and psychotic and in achylia gastrica. They arise also reflexly from diseases of other abdominal viscera such as the gall-bladder, appendix and the colon. They can be readily compared to the clinical symptom-group of fullness, pressure, pyrosis, belching and water-brash, which are common to so many functional and organic diseases arising from intra- and extra-gastric causes, not excluding even such remote conditions as tuberculosis, myocarditis, coronary disease, interstitial nephritis, etc. These group symptoms in themselves have no significance unless correlated with a definite clinical entity. Roentgenologically, as well as clinically, the indirect signs merely help to draw attention to an existing lesion without particularly specifying its character or location.

Cole in his work on the duodenal defect was the first to interpret duodenal ulcers on direct evidences of changes taking place in the duodenum. Numerous metaphorical terms were soon introduced in literature to specify the appearance of this defect. Carman and Miller [5,6] speak of the "pine tree" and "coral leaf" deformity and Holzknecht[7] of the "clover leaf." The term "defect," however, as employed here, is used in a broad sense, and does not make clear the actual pathological changes taking place in the duodenum. The meaning is unspecific and may equally be applied without any differentiation to an ulcer, scar, spasm, infiltration, adhesion or new growth.

In the roentgen pathology of gastric lesions the term "defective filling" implies a loss of substance or encroachment upon the lumen by a new growth. A gastric ulcer is always visualized as a crater filled with the contrast substance. As we shall see later, the factors that govern the roentgen pathology of duodenal ulcers are analogous to those governing gastric ulcers and the changes seen may be regarded as a miniature replica of the latter, such differences as exist being readily explained by the biological and anatomical characteristics as applied to the size and degree of irritability of the organ.

It will be the object of this paper to prove that a duodenal ulcer likewise manifests itself in the majority of instances in the presence of a niche and that the defect itself seldom represents the ulcer base proper.

Recently A. Åkerlund[8,9] of Stockholm took up at great length the studies of the duodenal deformity and attempted to interpret and classify these various deformities according to definite pathological and anatomical changes within the duodenum. He studied a series of 106 cases in whom he had the opportunity to compare the operative and autopsy findings with his series of roentgen findings in 69 cases. His work revealed that 60 per cent of duodenal ulcers manifest themselves in the form of a

* Presented before THE NEW YORK ACADEMY OF MEDICINE, Jan. 17, 1924.

niche, similar to the gastric ulcer. He studied the mechanics of the duodenum and its behavior under pathological stimuli and gave a new interpretation to the duodenal defect, differentiating morphologically the functional from the organic defects.

A series of 30 cases are here reported which were collected by me during a period of one year. They were all carefully studied by means of serial roentgenography, and many of them were reexamined under the influence of antispasmodics. The results were very gratifying in that 20 out of the 30 cases, i.e. 66 per cent, could be interpreted as niches. Only such cases were selected as gave classical symptoms of duodenal ulcer, and aside from the operatively proven cases, the others responded promptly to ulcer therapy.

ANATOMICAL CONSIDERATIONS

In order to understand fully the roentgen pathology of duodenal ulcers it is necessary to have a definite knowledge of certain anatomic and physiologic factors pertaining to the first portion of the duodenum, particularly the mechanism of its muscular structure. The first portion of the duodenum (bulbus duodeni) stands out from a structural viewpoint as a unique organ. Histologically it stands between the stomach and the small intestine, possessing some of the characteristics of both. It resembles the stomach in the absence of valvulae conniventes, possessing a smooth mucous membrane. This fact has made Cole consider it part of the stomach, naming it pilleus ventriculi (cap of stomach).

Duodenal Musculature. The muscular structure of the duodenum has a distribution somewhat similar to that of the stomach.

The longitudinal muscular coat completely envelops the duodenum. It shows, however, distinct variations in thickness in the different regions of the duodenum. Its greatest development and thickness can be seen along the lesser curvature border which is the continuation of the longitudinal muscular fibres of the lesser curvature of the stomach. This thickness is in marked contrast to other regions of the duodenum where the muscle bundles appear considerably thinner to the point of translucency, allowing the circular fibers to be seen through it. This enforcement of the longitudinal muscle fibers, forming a band as it were, along the lesser curvature border of the duodenum is a constant finding, and simulates somewhat the tenia coli. For the sake of convenience and due to the important rôle that this longitudinal bundle of muscle fibers plays in the mechanism of the duodenal bulb, it may be called tenia bulbus duodeni. It varies in width from 1 to 2½ cm. These fibers enter the pyloric sphincter and intertwine with terminal fibers of the longitudinal muscles of the stomach at the sphincteric ring. This arrangement is absent on the greater curvature side of the duodenum. Some of the longitudinal fibers enter also into the duodenohepatic ligament which is attached at the upper border of the duodenum and forms the only suspension mechanism of the duodenal bulb.

The circular muscle fibers, according to von Aufschneiter[10] originate in the lesser curvature border of the duodenum, running somewhat arc-like at an oblique angle to the longitudinal fibers at their point of origin, thus further strengthening the longitudinal bundle of fibers on the lesser curvature side (Fig. 1*a*).

This muscular arrangement of the first portion of the duodenum plus its suspension by the duodenohepatic ligament exert a strong influence upon the mechanism of the duodenum under pathological conditions, particularly upon the visualization and location of niches, and the roentgenological appearance of filling defects.

It is known that the place of predilection of ulcers in the duodenum is, as in the stomach, close to, or overriding the lesser curvature. Any irritation rising from an ulcer in this region causes an increased tension in the longitudinal muscle bundle, which, by virtue of its stronger contractile power and its suspension mechanism, forms a fulcrum towards which are drawn the circular muscle fibres in the same segment (Fig. 1*b*).

The effect is twofold. First, the drawing upwards of the adjoining tissues causes

the visualization of the ulcers in profile, as they would override the lesser curvature; second, a localized contraction of the duodenum in the same segment of the ulcer which causes a narrowing of its lumen and gives roentgenologically the appearance of a defect, this defect being often mistaken for the ulcer base proper.

Often the contraction may be so intense, as to interfere with the filling and visualization of the niche. It is this particular phase that I wish to emphasize. The administration of antispasmodics in full physiological doses for several days will invariably cause a relaxation of the spasm to such an extent that the defect is diminished in size or may completely disappear, while a niche which was invisible before is seen filled out on the lesser curvature border.

With this method one can markedly increase the frequency of the visualization of niches, thus making the niche the most common roentgen deformity of duodenal ulcers. It is only in the presence of a scar or a marked infiltration with considerable encroachment upon the lumen that a niche cannot be visualized. Here we have the organic defect or the classical Cole defect.

Borders. A word as to the borders of the bulbus duodeni. The lateral borders of the duodenum are usually symmetrical and slightly convex. Occasionally the lesser-curvature side may be shorter, assuming then a slightly concave appearance. The base of the pyloric border is usually straight; rarely it may present slight variations appearing concave or convex, but like the lateral borders is always smooth and sharply outlined. The transition between the pyloric border and the sides of the bulb is usually round.

Nomenclature of Borders. The writer finds it preferable to preserve the terms used for the stomach, that is, the lesser and greater-curvature borders, for in truth they are continuations of the gastric borders, and no matter what position or direction the duodenum may assume this terminology remains always unchanged. The terms employed, "inner and outer" border, are confusing, for if the duodenum assume a transverse course, these borders, "outer and inner" would become "upper and lower." If the course were downward, they would then become completely reversed to "outer and inner."

Peristalsis. Definite peristaltic waves analogous to antral contractions can often be seen, particularly when the duodenum is in an irritable state, which may not arise necessarily from any intraduodenal lesion. This deep duodenal wave is often seen in association with deep gastric peristalsis. More commonly, however, the tonus changes described by Chaoul and Stierlin[11] are noted, the duodenum decreasing uniformly in size in the act of evacuation. This may be compared to a collapsing balloon, when the air escapes under pressure. The peristaltic waves can be differentiated from duodenal deformities by their transitory nature.

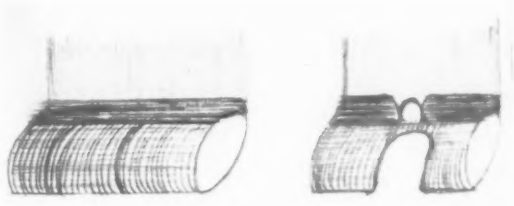

FIG. 1a. Diagrammatic sketch of the muscular arrangement in the first portion of the duodenum showing the thickness of the longitudinal bundle of muscle fibers at the lesser curvature border and the attachment of the duodenohepatic ligament.

FIG. 1b. Shows the mechanism of the muscular contraction in the presence of an ulcer at the lesser curvature.

Roentgen Pathology of Duodenal Ulcers. Duodenal ulcers manifest themselves roentgenologically in deformities which are dependent almost always upon a combination of two factors (1) organic changes (2) functional disturbances accompanying the organic lesion. The functional, like the organic changes, assume definite and characteristic forms.

Classification of the Roentgen Deformities in Duodenal Ulcer. The types of deformities encountered may occur singly or in a combination of any or all of them. They may be classified as follows:

(1) The *niche* is by far the most constant type and is dependent upon the filling of a crater by the contrast substance. It was found in 66 per cent of our series, 20 out of the 30 cases.

(2) The *defect*, a deformity which assumes definite characteristics as to con-

figuration and position, is usually associated with a niche, but may appear alone, and is the result, in the majority of instances, of functional disturbances. Less often it is due to organic changes such as induration, scar-formation and adhesions. It is most often seen on the greater curvature side.

course of the serial examination, and are the result of both functional and organic changes in the duodenum.

Our series of 30 cases revealed 20 niches, or 66 per cent, out of which 14 or 70 per cent were on the lesser curvature, 5 or 25 per cent were on the greater curvature, 1 was an en face niche.

FIG. 2. Niche at the lesser curvature border of the duodenum with retraction of the same border. Also spastic incisura at the greater curvature border in the plane of the niche. Operatively proven case.

(3) *Retraction*, another characteristic deformity, always in close association with the niche, is likewise dependent upon spasm and rarely upon organic changes. It is usually situated on the lesser curvature side and is manifested by a shortening of the same border.

(4) *Diverticula formations*, confined to the base of the duodenum, are pouch-like in character and differ from the niches by changes in size and shape noted in the

Twenty-four cases, or 80 per cent, presented defects, out of which 12, or 50 per cent, were associated with niches and 12 were not. Of the latter, 6 were organic defects, representing old callous ulcers. All the others were functional.

Nineteen niches or 95 per cent were associated with retraction, of which 12 presented an accompanying defect on the opposite side and 7 niches presented retraction only.

Diverticula in the sense of functional sacculations were met with in but 6 cases, the place of predilection being at the base of the duodenum.

The Niche. The occurrence of a niche in the duodenum was considered for a long time as a rare manifestation. In 1914, Carman[12] reported but two niches out of a series of 198 operatively proven cases of duodenal ulcer. Prior to him, in 1912, Bier[13] reported a case where roentgenologically a large penetrating niche was demonstrable which operatively was found to have penetrated into the liver. George and Gerber[14,15] however, in 1915, stated that with good technic a majority of the mucosal defects can be roentgenologically demonstrated. Akerlund in his series of 102 cases was able to demonstrate the presence of a niche in 60 cases, approximately 60 per cent. In my own series of cases a niche was demonstrated in 66 per cent.

The niche may represent any stage of pathological change in the duodenal wall from the simple non-indurated mucosal ulcer to the penetrating and callous ulcer and even an ulcer scar covered with mucous membrane. The filling and visualization of the niche is dependent not only upon the ulcer crater itself, but also upon the existing irritability of the surrounding musculature, especially the muscularis mucosa through whose constriction is produced a flask-shape appearance (Figs. 2, 3, 4). Often this irritability may be so intense that the entire ulcer-bearing area is puckered up in a state of undue contraction as a protective measure, not permitting

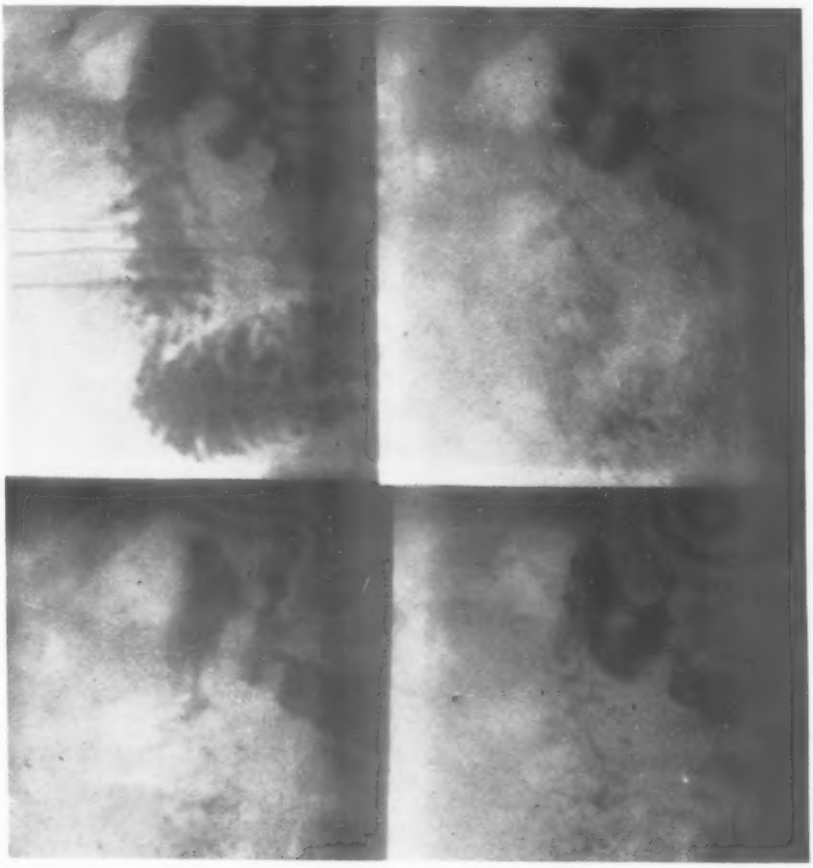

FIG. 3. Large niche at the lesser curvature border about ½ in. away from the pylorus. Retraction of the lesser curvature border and a marked function defect on the greater curvature side opposite the niche. Operatively proven case.

the contrast substance to enter the ulcerated area. Here, as we shall see later, the administration of an antispasmodic for a few days produces invariably a relaxed condition that allows the filling and visualization of a crater.

Place of Predilection. It is most commonly encountered on the lesser curvature side. Fifty-four out of 60 cases reported by Åkerlund were visualized on the lesser curvature. In our own series 14 were situated on the lesser curvature and 5 on the greater curvature (Fig. 5) and 1 was an enface niche (on mid-surface). Ulcers situated anatomically close to the lesser curvature, as has been pointed out, will appear roentgenologically on the lesser curvature, giving the impression, as it were, of overriding the lesser curvature. This is dependent upon the mechanical factors of the duodenal musculature before mentioned, that is, the structure at the lesser curvature border forms a fulcrum which by its stronger contraction causes the drawing upward of the adjoining tissue, with the result that even a lesion situated a short distance away on the anterior or posterior wall becomes approximated towards the lesser curvature side.

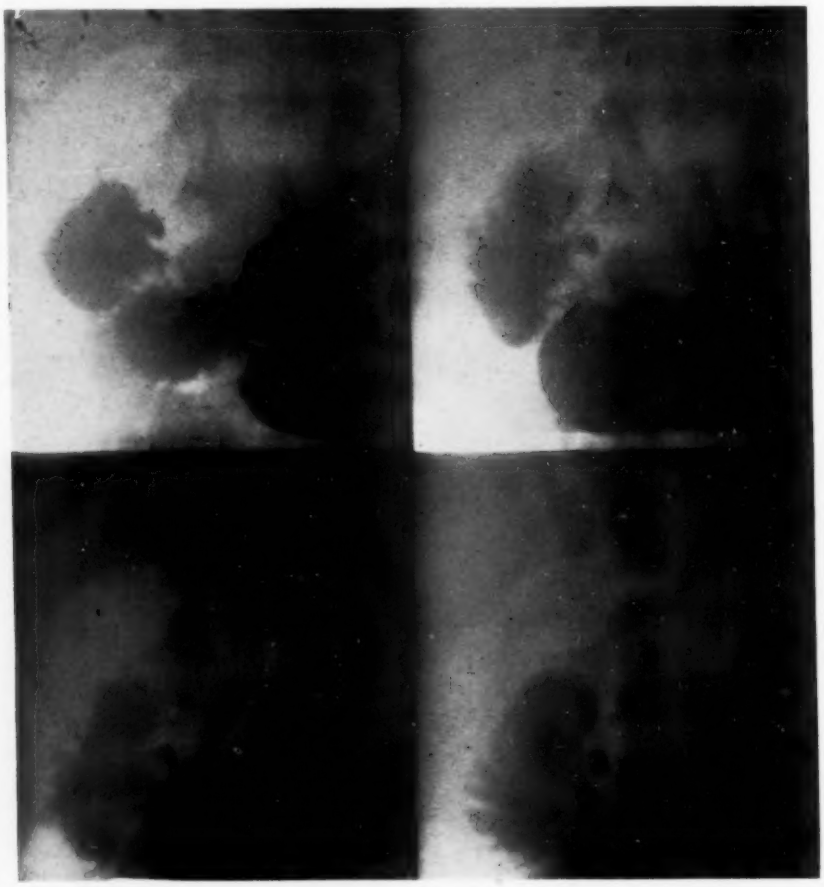

FIG. 4. Niche on the lesser curvature side with retraction of the same border.

The niche in the duodenum is often accompanied by characteristic deformities. These deformities are functional in character and are analogous to the roentgen signs accompanying gastric ulcer of the lesser-curvature type. They are, however, more constant and more pronounced in the duodenum than in the stomach. They are, as we shall see in the succeeding paragraphs, (*a*) the segmental contracture or incisura, appearing usually on the greater

curvature opposite the lesion and (*b*) a puckering or contraction in the immediate vicinity of the lesion. Niches on the greater curvature of the duodenum may appear as small diverticular projections and may or may not be accompanied by any other signs in the duodenum.

The Duodenal Defect. The term defect when used to describe duodenal pathology

Cole attributed the constant deformity in the duodenal contour to organic changes caused by induration or cicatricial contraction surrounding the crater of an ulcer and also to periduodenal adhesions. Later Carman[15] expressed the belief that a similar defect could be produced by a spastic contraction in the duodenal wall opposite to, or surrounding the ulcer-bearing area.

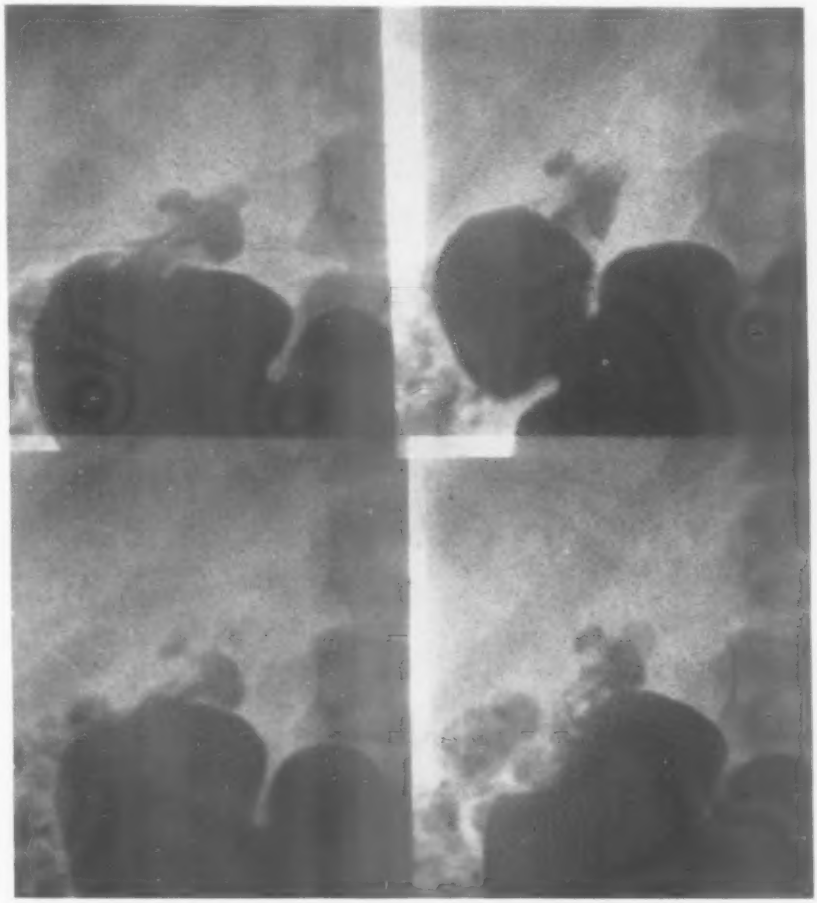

FIG. 5. Niche on the greater curvature side. Notice also diverticulum pouch at base of duodenum. Operatively proven case.

embraces all changes in form which may arise from muscular contractions or retractions, spastic incisuras, infiltrations, scar formations and constrictions resulting from scars. Also from extraneous causes such as pressure from neighboring organs and adhesions. Tumors of the duodenum are rare.

For a long time the defect was considered to be the result of organic causes only.

However, not until 1919 was there an attempt made to give definite interpretation of the pathogenesis of this defect. Åkerlund in his series of cases first observed the disparity between the roentgen findings and the operation or autopsy findings. The roentgen defects indicating extreme narrowing of the duodenal lumen are but seldom found during operation or postmortem. In this respect they are similar to

gastric incisuras or other forms of gastric spasm. These defects vary in size during the same examination and are considerably influenced by several days' administration of belladonna. It is the custom of the writer after the preliminary examination to administer to the patient 20 to 25 drops of tincture of belladonna every 4 hours for 48 hours, simultaneously restricting the patient to a milk diet. At times even alkalies may be necessary. A marked relaxation of the spasticity takes place so that the lumen of the duodenum appears

FIG. 6. Complete relaxation of the duodenum after several days' administration of belladonna and restriction to milk diet. Notice well-filled niche on the lesser curvature side and total disappearane of a previously existing defect on greater curvature side.

wider, and often a niche which was not visualized before is seen protruding from the lesser curvature (Fig. 6). Furthermore, these defects gradually diminish in size and actually disappear during prolonged medical therapy. One must conclude, therefore, that this local defect is due to a spastic contraction caused by the presence of an ulcer, somewhat analogous to gastrospasm opposite the niche. The organic causes such as induration, and scar formation play but a minor part in the formation of these defects. These are always accompanied by the spastic factor which is the predominating component.

The spastic defect is almost invariably found on the greater curvature of the duodenum, in the plane of the ulcer; occasionally at the base of the duodenum (Fig. 7) or in the region of the pyloric sphincter proper. Sometimes there may be an hour glass deformity, a circular spastic contraction arising from both borders of the duodenum.

The organic defect is more often found on the lesser curvature border.

The spastic defect is more or less rounded in outline, broad and often very deep, and possesses smooth borders giving the appearance of a finger-print (Fig. 3). These defects in the greater curvature may be wider than a finger's breadth and may at times occupy the major portion of the duodenum, encroaching deeply so that the lumen of the duodenum is reduced to the diameter of a match stick or a thread. It may so alter the configuration of the duodenum that the duodenum becomes difficult of recognition, being divided into two separate portions with or without any connecting link. Less frequently does the defect appear as a narrow sharp incisura (Fig. 2) of the type encountered in the stomach. These contractions may be double and adjacent to each other, or separated by a narrow tongue-like projection.

This segmental contracture is brought about by the contraction of the circular muscle fibers, and is likewise dependent upon the anatomical and mechanical factors before mentioned. These weaker circular fibers contract towards the fulcrum at the lesser curvature side. One gets the impression that a localized area of the duodenal wall is drawn up and bound as it were to the lesser curvature side (Figs. 3, 7). In lesions close to the base of the duodenum the pyloric sphincter is pulled over to the side of the lesion along with the spastic contracture. The defect can often be seen long in advance of the appearance of the niche and may persist after the niche has disappeared in the course of medical treatment. In cases where a niche is not visualized the ulcer is usually found opposite the defect. Organic causation enters less often into the formation of such defects.

The organic defects are irregular in outline, they may be angular and are constant in size. They lack the rounded form, the depth and variability.

In our series, 24 cases presented defects, out of which 18 were functional and 6 organic, the latter representing old callous ulcers.

deformity associated with a niche (Fig. 3). In well marked cases of unilateral retraction one gets the impression that only the outer half of the bulb is filled at that particular level. Similar retraction occurs in gastric ulcer in lesser curvature niches, the best illustration is the Schmieden and Hiertel snail-form or tobacco-pouch stom-

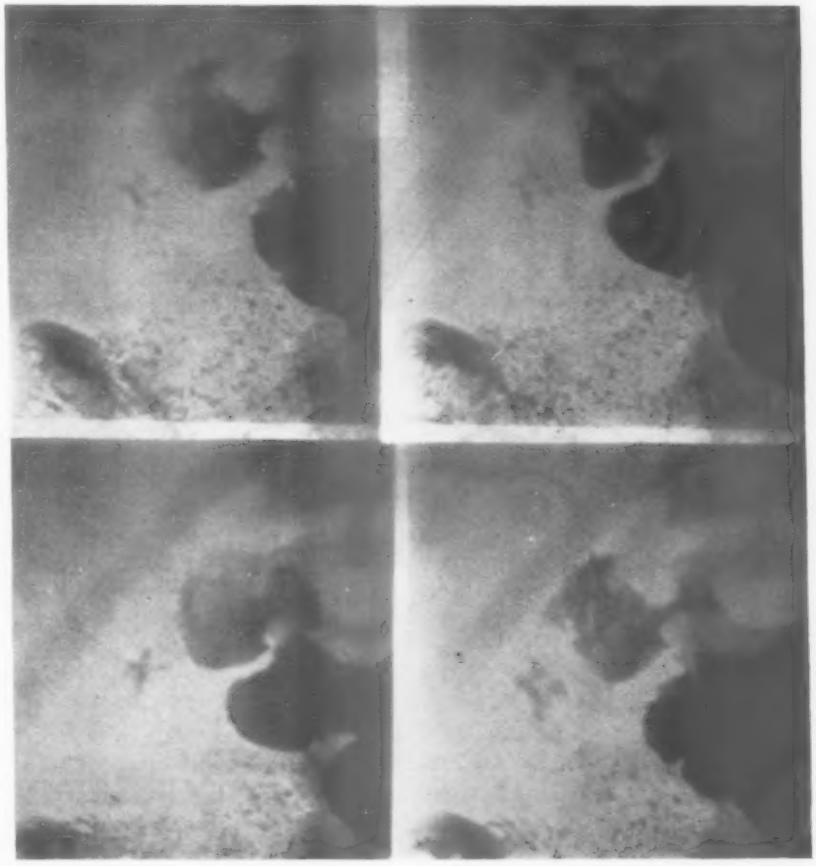

FIG. 7. Functional defect at base of duodenum accompanying mucous ulcer.

Bulb Retraction. By retraction of the duodenum is understood contraction of the longitudinal muscle fibers occurring usually on the lesser curvature border and always surrounding the base of a niche. The retracted side then appears shortened and drawn in for a short distance so that a normally convex border changes into a distinct concavity, from the center of which a niche protrudes (Figs. 2, 3, 4). When the circular muscle fibers are simultaneously in a state of contraction, we then have the picture of the classical

ach when the lesser curvature is shortened and there is an approximation of the horizontal to the vertical portion. This, of course, is an extreme illustration. Minor retractions surrounding the gastric niches are less manifest than in the duodenum in view of the fact that the lesser curvature of the stomach is normally concave in contradistinction to the convexity of the duodenal borders.

Diverticulum Associated with Duodenal Ulcer. The diverticulum associated with a duodenal ulcer consists of a pouching

of a portion of the duodenal wall situated in close proximity to the ulcer. They are characterized by containing an intact lining of mucous membrane. Roentgenologically, they are of significance in that they may be often mistaken for niches. They can, however, be differentiated from these by their ability to contract, changing in size and contour from plate to plate (Figs. 5, 7). They participate in function with the remainder of the duodenum and can be seen to fill and empty. The places of predilection are the basal portion of the duodenum. Carman and Miller speak of the diverticulum as a sac-like addition to the bulb, always proximal to the site of the ulcer. Åkerlund mentions two types of diverticula, the larger sacculation occurring mostly on the greater-curvature side while the smaller one, more circumscribed, appears on the lesser curvature. The larger sacculations on the greater-curvature side are the result of spastic contractions on the distal portion of the duodenum. The smaller diverticula on the lesser-curvature side usually take their origin from the formation of longitudinal folds in the vicinity of the ulcer, which result from the shortening and retraction of the longitudinal muscle fibers. The continued constriction of the lumen causes a prolonged back pressure which results in diverticulum formation. These latter are usually sharply circumscribed and are situated in close proximity to the pylorus and can be mistaken for the niche proper. Careful observation and study on the serial exposure will aid in the differential diagnosis.

Organic stenosis of the duodenum distally situated will also give rise to similar diverticula orally situated from the stenosis, the so-called "prestenotic diverticula." Traction diverticula are of rarer occurrence and are described by George and Leonard[17] as caused by the formation of adhesions to the surrounding organs, from periduodenitis in the ulcer region.

Non-pathological Deformities of the Bulb. In normal individuals changes in contour are met with occasionally. These are usually broad, smooth, arc-like depressions, mostly on the lesser curvature, but less often on its greater curvature. These are caused by pressure from a distended gall-bladder. Cole speaks of an indentation near the apex of the bulb which is due to pressure on the pars-descendens by the group of vessels running from the duodenum to the liver along the duodenohepatic ligament. These are the portal vein, the common duct and the hepatic artery.

CONCLUSIONS

Ulcer of the duodenum always produces morphological changes in the configuration of the duodenum. Only in rare conditions, in the absence of an accompanying spasm, such as in mucous ulcer, may the duodenum appear normal. In the series herein studied a definite anatomical deformity was noted in all. Aside from the operative cases only such material is here presented as gave clinically the classical symptom complex of duodenal ulcer and responded promptly to the therapeutic test. Cole holds that a symmetrical cap with a normal pyloric sphincter justifies a negative diagnosis of post-pyloric ulcer. Experience, however, has proven that a deformity which repeats itself in a series of exposures cannot be invalidated by the presence of one apparently normal bulb shadow. The variability of the accompanying spasm may at times obscure the lesion, especially a so-called enface niche and more so when situated on the posterior wall. Carman quotes several cases with a normal outline of the duodenum where upon exploration an ulcer was found. At times, however, the surgeon may be unable to find palpatory evidence of the ulcer when the roentgen ray indicates unmistakable evidence of ulcer. This occurs when the usual induration accompanying an ulcer is wanting as takes place in the superficial or florid ulcer. Numerous cases are cited in the literature (Cole[18] Åkerlund, etc.) in which the roentgen examination indicated the presence of a niche and on section at autopsy large superficial or deep ulcers were found, but no palpable ulcer could be demonstrated during laparotomy. One must take cognizance of this important phase of absence of palpatory signs of ulcer, and negative surgical diagnosis of ulcer is unjustifiable unless the duodenum is opened and inspected. We

must also recognize the fact that in some instances the roentgen diagnosis supersedes the exploratory laparotomy.

In the interpretation of the duodenal deformities an effort must be made to recognize the actual lesion taking place within the duodenum and express it from a pathological and anatomical standpoint. We must differentiate between a niche, infiltration, scar and spastic contracture. Errors will be eliminated if one will follow a definite plan and apply himself to study minutely the character of the changes in each border, always bearing in mind the pathological entities which affect the duodenum and the manner in which they express themselves under the roentgen ray.

SUMMARY

Several new phases in the understanding of the roentgen appearance of duodenal ulcers have been brought forth. An attempt was made to interpret the manifestations upon the basis of anatomical and pathological changes.

1. The architectural structure of the first portion of the duodenum and its influence upon the configuration of the duodenum in ulcer lesions has been gone into at length.

2. It has been shown that a supporting structure, or a fulcrum, is formed on the lesser-curvature side of the bulb brought about by the larger number of longitudinal muscle fibers continued from the lesser curvature of the stomach, forming a thick bundle, as it were, simulating the tenia coli which in view of its importance may be called "tenia bulb. duodeni." This is further strengthened by the suspensory effect of the duodenohepatic ligament.

3. A series of 30 cases are here presented revealing 20, or 66 per cent, niches, 18 functional defects, 12 of which are associated with niches, 6 organic defects representing old callous ulcers; 19, or 95 per cent, of the 20 niches revealed an accompanying retraction. Diverticula were noted six times

4. It has been shown that the most constant roentgen finding of the duodenal ulcer was the niche, which may vary from the mucosal defect to a deep penetrating crater.

5. It has been further shown that a duodenal defect is most often functional in nature and is produced by a contraction of the circular muscle fibers upon the longitudinal bundles on the lesser curvature side, and that it seldom represents the ulcer base, the ulcer being usually opposite to and in the same segment of the defect. Less often is the defect produced by organic changes such as scar formation or induration.

6. Another type of spastic contracture has been shown, "retraction," most often found on the lesser-curvature side, surrounding the base of the niche, and due to contraction of the longitudinal bundle itself, thus often intensifying the appearance and size of the niche.

7. The administration of belladonna for forty-eight hours and the restriction of the patient to a milk diet, invariably causes a relaxation of the accompanying spasm, thus permitting the filling of a niche which was not visualized in the previous examination. This method of reexamination has increased the number of visualized niches.

8. The occurrence of diverticula situated always orally to the lesion has been mentioned. These are usually pulsion diverticula produced by functional or organic constrictions in the distal portion of the duodenum. Their differentiation from niche has been pointed out.

9. Careful and detailed study of the duodenal contour in serial roentgenography based upon the above anatomical and pathological considerations will enhance the diagnosis of duodenal ulcer and reduce the failures to a minimum. The old indirect method has little or no value in the diagnosis of duodenal ulcers, particularly in the early stages, and cannot be relied upon, since a multitude of other conditions will give similar manifestations.

I wish to express my thanks to Dr. J. Fierstein for his assistance in the compilation of the literature.

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THE EFFECT OF DIRECT RADIATION OVER THE PRECORDIUM ON THE HEART SIZE, THE HEART MECHANISM AND THE MYOCARDIUM OF RABBITS*

BY BURGESS GORDON, M.D., G. F. STRONG, M.D., AND E. S. EMERY, JR., M.D.

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WITH the continued increase of roentgenotherapy in chest conditions which frequently involves exposure of the heart, especially in the treatment of mediastinal tumors, it seems important to know the effect of the roentgen ray on the myocardium as to pathology and function. Many excellent studies have been reported by Whipple[1,2] and his colleagues, and by Denis, Martin and Aldrich[3] on changes occurring in different organs after radiation, and their relation to general systemic reactions. So far, however, we have been unable to find any report except on the histological changes of heart muscle and these have been limited to studies on animals given comparatively large treatments and not observed for the effect of small frequent irradiations over the heart.

In this study sixteen rabbits were subjected to direct radiation over the precordium. Some of the rabbits were given large single doses or moderately large repeated doses, others received small doses at frequent intervals over a period of several months. Seven additional rabbits were radiated over the abdomen to determine any indirect effect of the roentgen rays on the heart. The total exposures varied from fifteen minutes to three hours and twenty minutes; the single doses varied from five minutes to one hour and fifteen minutes. The schedule, the amount of treatment and the weights are shown in the accompanying chart.

The technique used in giving the treatments was as follows: Each rabbit was placed on an animal board and held firmly in position on its back. The body except for the area exposed to radiation was covered with a leaded sheet supported by an upright standard. In the rabbits treated over the precordium the covering was adjusted so as to allow the penetration of the rays through an opening 2.5 by 3 cm. in diameter. In the rabbits studied for the effect of indirect radiation the

*From the Medical Clinic of the Peter Bent Brigham Hospital and the Department of Medicine of the Harvard Medical School; Submitted for publication Jan. 18, 1924.

opening over the thorax was covered and the part of the leaded sheet over the lower abdomen was removed. Electrocardiographic tracings and roentgenograms were made before radiation and at frequent intervals during treatment to determine any progressive changes that might occur in heart size, and rate or type of electrocardiograms. The roentgenograms were taken at a distance of 4 ft. with a spark gap of 4½ in., 30 ma. and an exposure of 7 seconds.

In estimating the changes in heart size the heart shadows were outlined on the roentgen film with pencil and a silhouette was traced from this on smooth white paper.[4] The silhouettes were then carefully cut and weighed, the weight being accurate to 1 mgm. In comparing the silhouettes the position of the animal was taken into consideration; when there was any marked evidence of distortion, the film was discarded.

It will be noted in the chart that one rabbit (Rabbit B) on which daily electrocardiograms were obtained over a period of three weeks, during which time the rabbit was receiving five-minute treatments twice each week, showed no change in the heart tracings. Other rabbits given less frequent treatment but in larger doses also failed to show the slightest variation in heart mechanism. The only electrocardiographic evidence of possible roentgen-ray effect occurred in Rabbit F which showed ventricular extrasystoles after two hours and five minutes of radiation given in fifteen minute doses once a week. These extrasystoles disappeared after treatment was stopped.

The roentgen-ray studies showed no appreciable change in heart size. In

Rabbit	Weight in Kg. at Beginning of Treatment	Weight in Kg. at Post-mortem	Weight of Heart in Grams	Amount of Each Treatment (Milliampere Minutes)	Frequency of Treatments	Total Exposure (Milliampere Minutes)	Evidences of Toxicity	Interval between First Treatment and Death	Interval between Last Treatment and Death
A	2.5	2.4	8.6	150	Every 3 wk.	1000		6 months	1 month
B	3.0	3.4	8.1	25	Twice each week	775	0	6½ months	5 weeks
C	1.8	1.8	5.35	225	Single	225	+	5 days	5 days
D	3.5	2.8	8.0	50	Once a wk.	150	+	15 days	1 day
E	3.8	2.8	8.8	225	Every 3 wk.	525	+	36 days	14 days
F	3.2	3.0	6.6	75	Once a wk.	1000	0	6 months	5 weeks
G	2.6	2.5	6.6	40	Twice each week	960	0	5 months	2 weeks
H	2.5	2.0	5.1	75	Once a wk.	750	slight	4½ months	5 weeks
I	2.3	2.3	6.35	300	Once a mo.	600	+	6 weeks	3 weeks
K	2.4	1.9	4.3	300	Once a mo.	900	+	4 months	7 weeks
L	2.5	2.5	7.1	375	Single	375	0	12 hours	12 hours
M	2.2	2.2	5.25	75	Single	75	0	18 days	18 days
O	2.5	2.5	6.2	75	Single	75	0	12 hours	12 hours
Q				75	Single	75	0	10 hours	10 hours
R				75	Single	75	0	12 hours	12 hours
S				75	Single	75	0	12 hours	12 hours
P	1.8	1.8	3.8	150	Single over abdomen	150	0	18 days	18 days
T				300	Single over abdomen	300	+	7 days	7 days
V				300	Single over abdomen	300	+	7 days	7 days
W				225	Single over abdomen	225	±	21 days	21 days
X	2.8	2.8	6.7	300	Single over abdomen	300	0	1 day	1 day
Y	3.4	3.3	8.3	300	Single over abdomen	300	0	1 day	1 day
Z	2.4	2.5	4.8	225	Single over abdomen	225	0	1 day	1 day

observing the rabbits treated over the thorax, many of which lived out of doors and were allowed to run in a large enclosure, no evidence of myocardial insufficiency was obtained. With the exception of those animals that developed infections, gastric symptoms, or loss of weight, all rabbits appeared in good health and maintained normal appetites. Deaths occurred in five animals of this group. Rabbits C and D succumbed to intercurrent infections. Rabbit E, suffering possibly from the toxic effects of a badly infected foot and an accidental exposure over the abdomen, died following a marked diarrhea. Rabbit H also died after four months of treatment and Rabbit I after two months of radiation, both suffering from pulmonary complications. All other rabbits irradiated over the precordium were killed by ether. Of the group treated over the abdomen, one animal was killed after eight days, not having shown any signs of toxemia. The other animals in the group were killed five to seven days after the onset of diarrhea. The heart silhouettes and electrocardiograms in these rabbits failed to show any change in heart size or mechanism.

There were no constant pathological findings in the hearts at post mortem. Rabbits E and D showed a few whitish spots on the myocardium and there were clumps of fibrin in the pericardium of Rabbit I. Otherwise the gross examinations were practically negative. The histology in several instances showed small areas of necrosis or fatty infiltration in the heart muscle, but the findings were not characteristic of any special degenerative myocardial change. They were not unlike the picture described by MacCallum[5] of the heart muscle during the course of varying infections, intoxications and nutritive disturbances.

SUMMARY

There were no definite changes in heart size, or histology to suggest that direct radiation over the precordium caused a diseased myocardium in rabbits. The pathological findings were not unlike those described in cases of infection and nutritional disturbances. Variations in the mechanism occurred in only one rabbit.

We wish to thank Drs. S. A. Levine, M. C. Sosman, and J. R. Wilson for many helpful suggestions during the study.

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INDICATIONS FOR ROENTGEN THERAPY IN CHRONIC TONSILLITIS AND PHARYNGITIS*

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THE tonsils and adenoids, as well as the adjacent structures involved in infections of the throat are composed of lymph tissue supported by a fibrous frame work. Lymphoid tissue in its simplest form is defined by Barnes as reticular connective tissue with a greater or lesser number of lymphocytes in its mesh. These lymphocytes cannot be distinguished from those in the blood. The lymphocytes may be scattered diffusely in the reticulum, or may be closely packed within a circumscribed area. The former is the simple or diffuse lymphoid tissue while the latter, in which the reticulum assumes a definite form, is called a lymph follicle. The lymph follicle contains lymphoblasts with mitotic figures of the nuclei, indicating the presence of embryonic tissue.

The changes in the chromatin of the nucleus of the lymphocyte is the first indication of the effect of irradiation. This is followed by degeneration and absorption of the cell which differs in no way from that of any other destructive process. The number of cells affected and the time the process of destruction and absorption takes place, depends on the amount of irradiation absorbed by these tissues. Investigators who have removed tonsils and adenoids some weeks or months after roentgen treatment report that they are unable to find any evidence of active destruction of lymph tissue. The time for such investigation should be when shrinkage and drainage are actually taking place and not after the cells destroyed by the roentgen ray have been absorbed.

Clinically, these same radiosensitive lymph structures play an important rôle in the various forms of leucemia, Hodgkin's disease and lymphosarcoma. The destruction and absorption of these cells with consequent shrinkage of the tumors in these cases is well established. Furthermore the destruction of lymphocytes in the circulating blood as proven by blood counts taken before and after roentgen exposures, indicates that the lymphocytes embedded in the lymph structures involved in infections of the throat may also be destroyed by the roentgen ray. This absorption of lymph elements produces not only a shrinkage from within but promotes eversion and drainage of the infected crypts; quite the reverse of sealing the crypts by the application of caustics to the mucous surface.

Another important factor in the effect of the roentgen ray on infected tissue other than shrinkage and drainage is the biochemical changes produced in the area exposed to irradiation. The results obtained in the past in the various infections of the skin and tuberculous glands, and more recently in diphtheria carriers, erysipelas, acute and sub-acute suppuration in pneumonia, malaria, acute and sub-acute sinusitis, pyorrhea and pertussis indicate that the roentgen ray produces changes in the tissues which interfere materially with the progress of the invading bacteria. This is further emphasized in the results obtained by roentgenotherapy in chronic pharyngitis and tonsillitis in which 80 per cent of those treated have been relieved of this condition, having been under observation for from one to three years.

Some of the cases after receiving roentgen treatment have had their tonsils removed because the examiner has found on culture various forms of pus microorganisms present. The bacterial flora of the throat before and after operation according to Pilot, Pearlmann and Davis remains the same; the only difference being a reduction in the number of the colonies after the operation. Cultures made from throats after roentgen treatment have been free from pathological microorganisms from a few days to several months. Sterilization of the throat is obviously impossible. The washings from the mouth and discharges coming from the nasal fossae

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are constantly bathing and contaminating these areas. The mere presence of pus bacteria is then no indication for either operation or roentgen treatment except in diphtheria carriers.

The permanency of roentgen-ray effects on the tissues involved in chronic pharyngitis and tonsillitis has been determined by the examination of the throats of those individuals who have been treated for tuberculous glands of the neck during the past ten years.

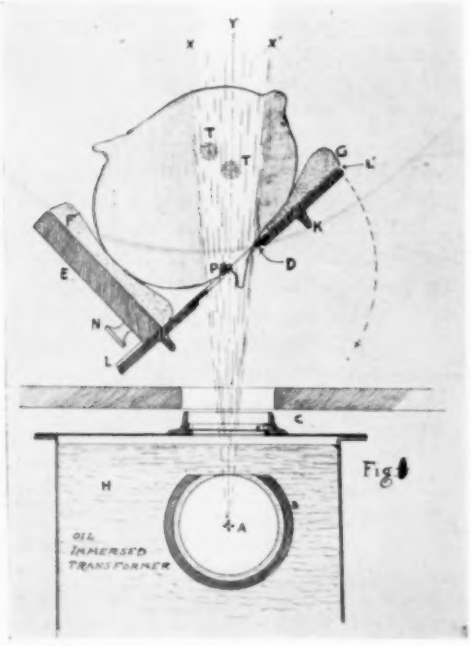

FIG. 1. Diagram showing the roentgen ray directed through the soft parts behind the angle and ramus of the jaw. A is target of the tube, C is filter.

FIG. 2. Patient in position for treatment of left side. Headrest tilted at angle necessary to avoid passing the ray through the angle and ramus of the jaw.

The tissues infected in cases of chronic pharyngitis and tonsillitis are not only the tonsils and adenoids but the lingual tonsil, infratonsillar nodule, lymph nodes on the lateral and posterior walls, lymph tissue in the fossa of Rosenmüller, and the cervical glands. Hence the operation at best removes only part of the tissues involved. Successful results following operations depend not only on the patient's power of endurance to withstand the operation but his ability to overcome the infection remaining in the adjacent structures.. This is true of any procedure directed solely to the tonsils and adenoids. A large percentage of patients treated by the roentgen ray give a history of from one to three operations for the relief of this condition.

None of the complications or contraindications in the surgical removal of tonsils and adenoids interfere in any way with the judicious use of roentgen therapy. The improvement noted in some forms of deafness is no doubt due to the relief of pressure on the eustachian tube by the shrinkage of the lymph tissue in the fossa of Rosenmüller.

The shrinkage and drainage of the structures involved in chronic pharyngitis and tonsillitis are dependent on the relative amount of radiosensitive cells and fibrous tissue present. The large soft tonsil reveals the most spectacular results. The small fibroid tonsil containing relatively less radiosensitive tissue and being smaller in size, shows less marked changes. The fibroid tonsil has undergone fibrous degeneration, indicating that the infection is chronic in character and more or less controlled by the fibrous process as exemplified in other forms of infection. This type of tonsil is often embedded in infected tissue and associated with a marked infection of the adjacent structures from which absorption is taking place to a greater extent than from the fibroid tonsil itself. Not all large tonsils are soft—some are firm and fibrous. Neither are all small tonsils fibrous; some are soft

and show marked reduction in size after irradiation.

CONCLUSIONS

Roentgenotherapy given previous to operation materially lessens the amount of dissection necessary for the removal of tonsils, thereby decreasing the possibility of complications.

Roentgenotherapy is recommended in the following cases:

1. Where an anesthetic or operation is contraindicated.

2. Those cases past middle life where hemorrhage may cause complications due to a mild or severe arteriosclerosis.

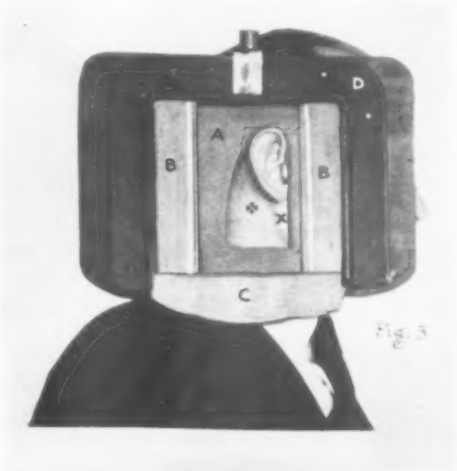

FIG. 3. Area exposed. X is the angle of the jaw; ✠ indicates the point of entry of the central beam.

3. Patients whose tonsils are embedded in infected tissue in which the operation may cause dissemination of septic emboli into the blood and lymph streams, thus producing lung abscess, septicemia, endocarditis, etc.

4. Patients whose adjacent lymphatic structures (not removable by operation) are markedly infected.

5. Patients suffering from chronic cardiac lesions, Bright's disease, diabetes, exophthalmic goitre, chorea, rheumatism, hemophilia, asthma, tuberculosis, status lymphaticus or any condition which has lowered the patient's general resistance.

6. Patients subject to frequent attacks of peritonsillar abscess (quinsy).

7. Vocalists and public speakers subject to frequent attacks of tonsillitis and pharyngitis.

8. Patients suffering from recurrent attacks of pharyngitis after removal of tonsils and adenoids.

Some of the unfavorable results obtained by this method may be accounted for by the fact that the ray was directed through angle and ramus of the jaw instead of through the soft tissues behind the jaw.

The accompanying illustrations show the positions and angles recommended by the writer.

DISCUSSION

DR. GERBER, Providence, R. I. I have felt deeply indebted to Dr. Witherbee from the first presentation of his method. I had the privilege of listening to him when he first publicly brought the method out. Since that time I have followed the modifications and finally settled down to the method as worked out by Witherbee. I was especially pleased today to note the moderation in tone of the entire paper as presented this morning. I am glad to note the feeling that there is to be no hostility nor competition between this method and rational, legitimate nose and throat surgery. I have always felt, and I feel more strongly now after approximately three years of experience, that surgery of the tonsils is by no means going to be eliminated by roentgen-ray treatment; absolutely not. The roentgen ray will have its definite, legitimate, restricted field, and the surgeons will have theirs. It is true that surgery of the tonsil in an adult is dangerous, but much of the danger is due, not so much to the operation, as to the fact that the great majority of tonsil operations are done upon patients who have not had a careful physical examination immediately before the operation, in an effort especially to rule out the presence of recent or acute infections of the upper respiratory tract. Those men who are very careful to see that the patients are in proper condition and postpone their operation if necessary, do not get lung abscesses. Aside from actual tonsillitis, I feel that the tremendous field of roentgenotherapy is to be in the field of adenoids and the rest of the lymphoid ring around the nose and throat; in types of chronic pharyngitis, and especially among the ranks of the great mass of people after middle life who form very poor surgical risks or have contraindications. I

want to bring forward one technical feature which I think may be of advantage. In talking over with the nose and throat men the method of treatment, I thought it might be worth while to use the highly filtered homogeneous rays for the tonsil case. We had a case, the second one I have seen, of leptothrix infection of the tonsils, one of the types of mouth fungi that get a firm hold not only on the tonsil but the adjacent structures with very large, white, glistening plaques filling crypts and apparently fastened in the lymph adenoid tissue. It would have been very rash to have attempted to operate. With the patient in the same position that we use in the lighter repeated treatment with the Witherbee method, I employed the 200 kv. highly filtered rays, and gave a sufficient dose in 2 sittings on successive days, one on each side, so that the entire Waldeyer's ring was bathed with approximately a 30 per cent dose. The patient had a very uncomfortable time for one week with swelling and discomfort and hoarseness. At the end of a month the crypt had shrunken, everted and most of the evidence of the leptothrix infection had disappeared. At the end of two months there was practically no evidence of the disease. It looked as if the tonsils had actually been excavated; there was a deep hollow between the pillars different from anything I have ever seen with the older technique. I do not offer that as a substitute for smaller doses repeated, because I believe that it has its advantages in destroying the adenoid tissue and not affecting the normal tissues, but I think it will prove to have a place in certain types of infection of the tonsillar ring.

Dr. Hickey. There is one angle of this question of roentgen treatment of the tonsil which has a geographical importance, I think. In the area immediately around the western part of Lake Erie we have the question of thyroid much more prominently before us than in some other parts of the country, and coincident with that prevalence of thyroid disease we have a very marked prevalence of the enlarged thymus, so much so that no tonsil operation in our part of the country, at least, around Ann Arbor, is undertaken without a preliminary roentgen-ray examination to see if there is an enlarged thymus. At our pathologic conference on Friday afternoon we have very frequently cases presented which have shown acute thymic death. One case which I heard about some two weeks ago, a child perfectly well at eleven o'clock at night, taken with very acute suffocative symptoms, and died before five o'clock the next morning, which was a true thymic death. And so we find that there is more of a tendency to use the roentgen-ray treatment in certain cases of tonsillar enlargement in children than if this question of thymic complication were not present.

Dr. Simpson, Washington, D. C. I think Dr. Witherbee is to be congratulated as a pioneer in this work. I was anxious to hear this paper in the hope that he possibly would have some changes in technique whereby we would improve our results and cut down the number of treatments. I have been interested in comparing the results of roentgen-ray treatment with radium applied directly to the tonsils, and I worked this out in a number of cases of treating one side with the roentgen ray and the other with radium plaques. This radium plaque is an oval shaped arrangement about the size of a lima bean, no angles or corners to it. I give the exposures half an hour on either side. In addition to that I give the Witherbee technique on the other side. There is a remarkable difference in the results of these two treatments. With the radium and the roentgen ray combined we can cut down the number of treatments to, as a rule, three. Sometimes we have to give four, but I do not think I have had a single case where I have had to give five treatments. The average patient can be cleared up in three treatments. My experience with the roentgen ray alone is that only in a minority of the cases can we clean up the fossa sufficiently to satisfy the nose and throat specialist, but this you do accomplish when you apply radium directly to the tonsil. The fossa is empty, possibly a small amount of fibrous tissue down at one end. This pack arrangement that I have been using for two years and a half cannot be applied to all cases; it cannot be applied to children, so that in children I have been using the emanation seeds. In my early cases my seeds were a little stronger than they should have been, they contained more than half a milicurie of emanation. The result was that I had a wound of the tonsil that was very hard to heal. I think it was more an infection than it was actual damage from the radium, but some of these patients developed severe earache, and healing of the wound was very slow. Since then we have been using about a fourth of a milicurie in the tonsils. If the tonsils are unusually large, put two seeds in it; be sure that your seed is surrounded by at least three quarters of a centimeter of tonsil in order to keep the ray from the pillar. In refractory and young children, this is a very easy method of treatment, but for adults, the pack is the treatment, combined with the

roentgen ray. I have had a number of cases where I used the roentgen ray alone on one side and the two combined on the other side, and one treatment of the combined method approximately represents four or five treatments with the roentgen ray. I have come to the conclusion that with the combined pack and roentgen ray I can cut down the number of treatments to half and really get a better result in the end than I can with the roentgen ray alone.

Dr. Grier, Pittsburgh, Pa. I have treated several tonsil cases by the application of radium outside. I have not heard anybody say anything about this. The results seemed to me to be about the same as in the treatment with the roentgen ray. I would like to ask Dr. Witherbee whether he has had any experience with radium applied externally and if he knows any objection to it?

Dr. Witherbee (closing). In regard to radium, I know very little about the application of radium, but it seems to me this point might be raised, that there is a possibility of radium having some effect on the pituitary gland; one lobe of the pituitary is lymphatic, and I feel that we can direct the roentgen ray well in front of that without raising that question at all. So far as the small doses are concerned, and the number, I feel that if you can do your work without causing the patient any discomfort, and allow the changes in the other structures in the throat to take place gradually, you get much better results in the end and the patient will feel more gratified. So far as deep therapy is concerned, I should feel a little bit the same as I would about radium. I believe one of the points made in the discussion was that it is not so much the amount of shrinkage or the number of bacteria you can get out of the throat, as it is the general condition of the patient and the freedom from the recurrent attacks of tonsillitis and pharyngitis. This is quite evident in those cases that have been operated upon. I think that the immunity produced is well illustrated in the various other infections treated by the roentgen ray. Of course any one who follows a technique and has a rigid rule of so many treatments for each case and then waits until some of them come back, and does not follow them up, is going to have more cases that require to be operated on than would happen where they are more carefully looked after. I make it a rule to wait two months after the eighth treatment and examine them again, and if necessary give them two more treatments and have them come back for a year or two afterwards occasionally if they have any trouble.

A CASE OF MELANOSARCOMA TREATED WITH ROENTGEN RAYS*

BY ARTHUR K. OWEN, M.D.

TOPEKA, KANSAS

A DESCRIPTION of this case is as follows:

Female, aged fifty-nine.

Family History. Negative.

Present Illness. In June, 1919, a small mole that had always been present on the anterior surface of the right forearm began slowly to enlarge and to become slightly painful. In September, 1919, the patient consulted a physician who cut off the top of the mole with a pair of scissors. The growth gradually recurred, however, and in December, 1919, she consulted another physician who put some kind of salve on it. This did not destroy it, for in five or six weeks it began enlarging again. In February, 1920, her physician tried to remove it by tying it off with a fine wire. This caused profuse hemorrhage and removed only the top of the tumor, which began immediately to enlarge from the base. In April and May of 1920, cautery and fulguration were tried, but without any benefit, as the tumor rapidly increased in size. In the latter part of June, 1920, her physician consulted with a surgeon who made the diagnosis of melanosarcoma and suggested that the arm be amputated at the shoulder, but held out no hope that the operation would give much relief. The operation was refused and the patient was referred to me on July 1, 1920.

The tumor at this time was of a dense black color situated in the mid-part of the anterior aspect of the right forearm. It was 4 cm. long, 3 cm. wide and was elevated 3 cm. above the skin surface. On the posterior aspect of the forearm and 5 cm. mesial to the primary tumor,

* Presented with application for membership in The American Roentgenology Ray Society, 1922.

were three smaller tumors situated deeply beneath the skin, all three jet black in color and easily palpated. There was a tumor in the right axilla the size of a large hen egg.

Treatment. On three successive days, July 1, 2 and 3, 1920, the patient received a half-hour of unfiltered *x*-rays over the tumor mass, a total of one and a half hours in the three days. A 10-in. spark-gap measured between blunt points, 5 ma. of current and a 10-in. target-skin distance were used. The tumor was exposed through an opening in sheet lead which extended ½ cm. beyond the margin of the tumor. On the same three days, the entire arm from the wrist up, the axilla, the shoulder and the right chest received an hour each day of filtered *x*-rays, a total of three hours in the three days, a 10-in. spark-gap, 5 ma., 14-in. target-skin distance 6 mm. of aluminum and 5 mm. of leather being used for a filter. Each skin area received thirty minutes. She reported back in August, 1920: at this time the elevation of the tumor was reduced while its circumference was slightly increased. She received another half-hour of unfiltered *x*-rays (10 in. sp. g., 5 ma., 10-in. target-skin) over the tumor, and one and one half hours of filtered (6 mm. Al. 5 mm. leather) *x*-rays over the arm, axilla and chest, with a target-skin distance of 14 in. This same dose, a half-hour unfiltered, and one and a half hours filtered over the arm, shoulder and chest, was repeated in September, October and November, 1920. At the November treatment the site of the original tumor was occupied by a depressed ulcer. The axillary enlargement was very much smaller.

The patient did not return to me until February of 1921, after an absence of over two months. At this time the site of the original tumor had largely healed in a depressed scar, in the bottom of which was a considerable amount of black pigment. The three smaller metastases on the opposite side of the arm could be seen as three areas of black pigmentation, but they could scarcely be palpated. The tumor in the axilla was entirely gone. She received three more treatments, all filtered as above, the last being given April 28, 1921. At this time treatment was discontinued and the patient was asked to report back every three months for observation.

She has made her third such return, and now, January, 1922, still remains free from her former trouble. The depressed scar at the site of the original tumor is entirely healed, but still contains the black pigment in its base. The three smaller tumors on the opposite side can still clearly be seen as three areas of black pigmentation, but they cannot be palpated. The axilla is still entirely clear. In September, 1921, an examination of the chest showed both lungs clear. Now, nineteen months after beginning treatment, all signs of the tumors have disappeared and the patient is perfectly well.

Note made Aug. 24, 1923. The patient was in this afternoon, three years and twenty-four days after initial treatment. The site of the original tumor is still a depressed scar, in the bottom of which are several areas of black pigmentation. The three metastases on the posterior surface of the forearm are still to be seen as three areas of pigmentation, but there has been no change in their size in the three years. The skin on both the anterior and posterior surfaces of the forearm contains a number of small petechiae, as does also the skin about the axilla. The axilla is clear.

The doctor who referred this patient to us had a series of slides of the tumor made and the pathological report of them was melanosarcoma.

Résumé of Treatment. A half-hour on three successive days of unfiltered *x*-rays over the tumor mass, using a 10-in. gap between blunt points, 5 ma. of current and a target-skin distance of 10 in.

A half-hour of unfiltered *x*-rays over the tumor area repeated once each month for four months (10 in. sp. g., 5 ma., 10 in. target-skin distance), making a total of three and one-half hours of unfiltered *x*-rays in five months.

Thirteen and a half hours of filtered *x*-rays using a 10 in. gap, 5 ma. current, 14 in. target-skin distance, with 6 mm. of aluminum and 5 mm. of leather as a filter, given in eight months over arm, axilla and chest.

MASSIVE COLLAPSE OF THE LUNGS

BY MAX RITVO, M.D.

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BOSTON, MASSACHUSETTS

DEFINITION

TOTAL or partial collapse of the lung occurring particularly after operations and injuries, and characterized by dyspnea, dulness over the involved area and marked displacement of the heart and mediastinal contents to the affected side.

SYMPTOMS

Massive collapse of the lung occurs in two forms, the latent and the acute. In the latent form there are no symptoms, the condition being recognized by the physical signs and the typical roentgenogram. The acute form, however, comes on very suddenly, the onset often being of such suddenness as to suggest pulmonary embolism, acute pneumothorax, or even sudden heart-failure. The first symptom is usually severe dyspnea, the respirations being very short and greatly accelerated. The shortness of breath is very urgent, and even the slightest exertion increases it markedly.

This sudden onset may be preceded, in some cases, by a period of a few hours in which the patient complains of vague pains, or rather, an uneasy feeling in the chest; a rising temperature has been observed during this premonitory period.

Cough may be absent at first. After the first few days, however, there is a productive cough with much thin, watery sputum. The sputum may be mucopurulent and have a slightly offensive odor; it may, very rarely, be rusty. Pain is not a common symptom; if present, it is not severe and lasts but a short time.

The temperature is moderately elevated, 101° or 102°F. being the rule. The rise in these instances has been compared to that seen in pulmonary embolism. The pulse is rapid, the increase in rate being proportional to the temperature rise. If the temperature rises to 104° or 105°F., pneumonia or other complication should be suspected.

SIGNS

The patient is cyanotic and in obvious respiratory distress. The affected side is retracted and moves but slightly or not at all with respiration. There is marked dulness or flatness over the involved area. If the collapse is on the left side, there may be resonance to an unusually high level in the left axilla because of the elevation of the diaphragm. Tactile and vocal fremitus may be diminished or absent; more commonly, they are increased, with bronchophony and pectoriloquy. In the beginning there are few or no rales; after the first few days, rales become very profuse.

The heart and mediastinal contents are markedly displaced to the affected side. The cardiac impulse may be in the left axilla or in the right nipple line. The heart is displaced both laterally and upward. This sign is typical of massive collapse; if the collapse is bilateral, however, there may be little or no displacement of the heart.

ROENTGEN EXAMINATION

The involved portion of the lung shows diminished radiance. The dulness is usually of a somewhat mottled character and of about the same density as the heart shadow. The diaphragm on this side is high and motionless. If the lower lobe is involved, the shadow of the diaphragm merges with the dulness of the collapsed area and is obliterated, or seen but very indistinctly. It is possible, when the process involves the left lower lobe, to demonstrate the elevation and fixation of the diaphragm by inflating the stomach with gas. The heart and trachea are markedly displaced to the affected side. The uninvolved side appears unusually bright, the interspaces on this side being widened, and the diaphragmatic excursions are greater than normal.

ETIOLOGY

The causes of massive collapse of the lung are diphtheritic paralysis of the diaphragm, gunshot wounds, injuries and abdominal operations. Operations for appendicitis and hernia are among the most common causes. Collapse has been seen after operations on all parts of the abdomen, with all anesthetics, and even with no anesthetic. Bradford reports massive collapse after fracture of the pelvis or femur; with wounds of the buttocks, thighs, or abdomen; and in gunshot wounds of the chest. Even a non-penetrating wound of the chest with no fracture of the ribs and no smashing of the chest wall has been followed by collapse of a whole lung. After an injury, be it slight or severe, the collapse may involve the lung on the same side, the opposite side, or may even be bilateral. There may be collapse of one or more lobes on the same or both sides.

The onset is usually within the first twenty-four hours after the exciting trauma, though it may be delayed for several days. The duration, similarly, varies from a few days to three weeks.

The mechanism of the collapse has not yet been agreed on. Pasteur believed that reflex inhibition of the movements of the diaphragm or paralysis of the muscles which are the direct distenders of the lungs, i.e., the diaphragm and the intercostals, as in diphtheritic neuritis, was the cause of the collapse.

Quoting from Fox, he classifies the causes of collapse of the lung as follows:

1. Congenital non-expansion.
2. Obstruction of the bronchial tubes.
3. Pressure on the lungs by fluid or solids.
4. Pneumothorax.
5. Imperfect power of expanding the thorax.

It was his opinion that the paralysis of the diaphragm, by causing imperfect power of expansion of the thorax (5) acted as a deflating force which compressed and emptied the lung of air without there being any bronchial obstruction, thus causing an "active" collapse. The recumbent position and deficient respirations during operations and after injuries have been advanced as probable causes of the fixation of the diaphragm; also, involvement of the diaphragm in peritonitis has been thought to cause inadequate respirations.

Another theory to explain this phenomenon was that the immobility of the diaphragm allowed secretions to block the bronchioles and that the collapse ensued as a consequence of this blockage. Lichtheim in 1878 had produced collapse experimentally in rabbits. Without opening the thorax, he inserted a laminaria plug into the bronchus, so that air could neither enter nor leave that portion of the lung; as a result, the air in this region was absorbed into the blood, the involved area collapsed, and the heart and mediastinal contents were displaced to the affected side. This collapse did not take place if the blood-vessels to the lung were tied. In this case the collapse was "passive," as against the "active" collapse of Pasteur.

Bradford finds it difficult to accept either of these theories. Thus, there often is no post-mortem evidence of bronchial obstruction, and it does not appear probable that a comparatively trivial injury of one side of the chest should cause paralysis of the muscles of respiration on the opposite side. Hirschboeck, one of the latest to write on this subject, states his belief as follows: "Bronchial obstruction and muscular immobility tend to bring about this condition, the one factor or the other predominating in the individual case, leading to alveolar absorption and massive collapse." This appears to be the most likely explanation at the present time.

PATHOLOGY

The involved portion of the lung is blue or violet in color and sharply demarcated from the normal lung tissue. It is soft, tough and wet; it feels heavy, does not crepitate, and sinks when placed in water. Microscopically, the alveolar surfaces are closely approximated, the alveolar spaces being obliterated.

TREATMENT

Preventive measures would, undoubtedly, reduce the incidence of massive collapse. During operations and after

injuries, the respiratory movements should be unhampered. The early use of antitoxin has practically eliminated the cases which come on after diphtheritic paralysis of the diaphragm. During the period of respiratory distress at the time of the acute onset of the attack, there are no measures which will afford relief, though oxygen inhalations may be of value in very severe cases. After the acute stage has passed, deep breathing exercises and blowing into a bottle are believed to expedite the re-expansion of the lung.

REVIEW OF LITERATURE

Pearson-Irvine[1] in 1876 described a condition clinically similar to massive collapse and thought it was due to the paralysis of the muscles concerned in the elevation of the upper part of the thorax. Two years later, Lichtheim[2] produced collapse experimentally in rabbits by plugging the bronchus; the air thus imprisoned in the lung was absorbed into the blood stream and collapse of the involved area resulted. In 1890, Pasteur[3] reported 34 cases of massive collapse of the lung occurring in patients with diphtheritic paralysis of the diaphragm. He was the first to identify this condition as a clinical entity and he applied to it the name "massive collapse of the lung." In 1908 he delivered the Bradshaw lecture,[4] choosing massive collapse as his subject. He believed that the collapse was generally caused by paralysis of the diaphragm and intercostal muscles; and that reflex inhibition of the diaphragmatic movements might lead to the same result. In his last paper in 1914,[5] he reported 16 cases which had occurred after 2,000 abdominal operations; in this group of 2,000 cases, there had been a total of 65 postoperative pulmonary complications.

A few months after the appearance of Pasteur's paper in 1914, Elliot & Dingley[6] reported 11 cases of massive collapse. These had occurred during a period of two years and all had followed abdominal operations such as appendix, gall-bladder, gastroenterostomy and hernia. They advanced the theory that the immobility of the diaphragm allowed secretions to block the bronchioles and that collapse then ensued. In 1918, Crymble[7] reported several cases occurring after gun shot wounds.

Bradford[8] in 1920 published a very complete paper on this subject. He finds it difficult to accept either of the theories already advanced. He states: "There is often no clinical or post-mortem evidence of bronchial obstruction, and it is particularly difficult to explain the frequent absence of symptoms if the obstruction is of bronchial origin. On the other hand, it is not easy to understand why a comparatively trivial injury of one side of the chest should cause a reflex palsy of the respiratory muscles on the opposite side; but on the whole, it would seem that this explanation is the more probable."

Briscoe,[9] also in 1920, published a paper entitled "The Mechanism of Post-operative Massive Collapse of the Lungs." He states: "The phenomena of the post-operative massive collapse attack are produced by the onset of inflammation affecting the muscles of the crus situated behind the peritoneum. My contention is that one-half of the diaphragm and its synergic and antagonistic muscles are out of action owing to inflammation of the muscle or of the pleural membrane covering it."

In 1921, Scrimmger,[10] reported 7 cases occurring in a series of 540 consecutive operations over a period of one year. Other papers on massive collapse have appeared during the past two years by various authors, among whom may be mentioned Scholtz,[11] Elwyn and Girsdansky,[12] and Hirschboeck.[13]

REPORT OF CASE

Male, white, aged twenty-eight, a laborer by occupation. Entered the hospital for relief of adhesions following an operation for appendicitis.

Past History. Nine years ago he had an operation for the repair of bilateral femoral hernia, and made a normal convalescence. About a year and a half ago he was operated upon for appendicitis. The wound was drained for a week, and then healed slowly. One year ago he was operated upon for an inguinal hernia; both the operation and convalescence were uneventful. Remainder of past history unimportant.

Present Illness. Ever since the appendectomy with drainage about one year and a half ago, he has had pain in the lower right quadrant. There is a dull ache almost constantly in this region; and on straining or exertion, it becomes a sharp, nonradiating pain. He has some nausea, but never vomits. Bowels move regularly. Appetite is good. There has been no loss of weight and no night sweats, cough, or sputum.

Pbysical Examination. A well-developed and nourished, rather thin young man. The heart and lungs are entirely negative. The abdomen is soft. The right rectus incision appears thickened and there is marked tenderness over it. The scars of the other operations are firm and painless.

A diagnosis of ventral adhesions in the right rectus scar was made and lysis of the adhesions decided on.

During the three days which the patient spent in the hospital prior to operation, his temperature was 98.0° to 98.6°F., pulse 76–80 and respirations 20.

Operation. Morphine and atropine were given preliminary to operation. His preoperative condition was reported as good. Gas-ether anesthesia was used, the operation lasting fifty-eight minutes. There was no shock or other apparent complication and the patient arrived on the ward in good condition.

The evening following the operation, he felt comfortable, temperature being 99.6°F., pulse 74, respirations 20. The following morning, he suddenly complained of shortness of breath and a feeling of tightness across the chest. There was a sudden sharp temperature rise to 102.0°F.; the pulse rose to 105, and respirations to 30. He had a slight cough and raised a moderate amount of thin, yellowish sputum.

Physical examination showed diminished excursion of the right chest. There was dulness and bronchial breathing over the entire right side. The left chest was hyperresonant. The cardiac dulness and heart sounds were displaced markedly to the right. No rales were heard at first; after the third day, however, numerous fine rales appeared. The white count was 11,400.

During the first five days, the patient's condition remained essentially unchanged. *X*-ray examination at this time (Fig. 1) showed markedly diminished radiance over the entire right lung-field. This dulness was of a mottled character in its upper portion, becoming more uniform and of a greater degree of density as it approached the base. The right border of the heart and

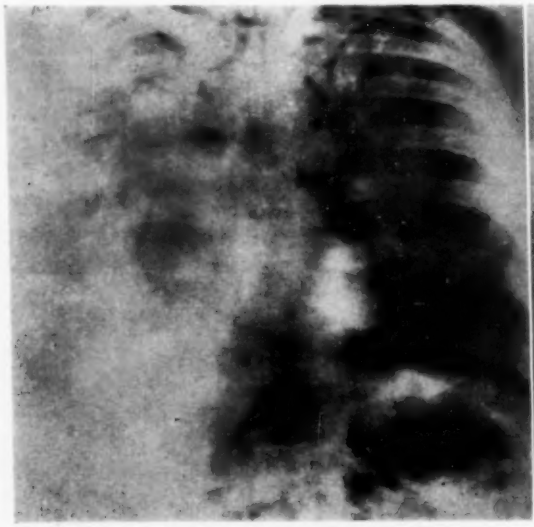

FIG. 1. Massive collapse of the right lung. Shows the marked displacement of the heart and trachea to the affected side.

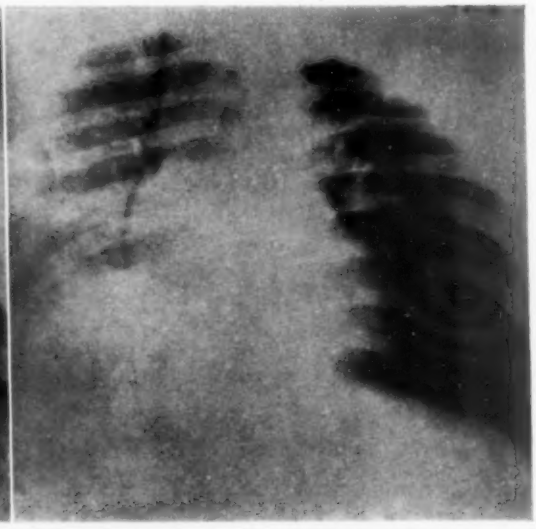

FIG. 2. Same, five days later. The right lung is beginning to clear. The heart and trachea are still markedly displaced to the right side.

the right diaphragm merged with this dulness and were obliterated. The trachea was displaced markedly to the right, its outline being distinctly visible to the right of the sternum. The heart, also, was markedly displaced to the right, the left cardiac border being near the left sternal edge. The left lung-field was unusually bright and the interspaces on this side were widened. The left diaphragm was normal in contour and position; its respiratory excursions were increased.

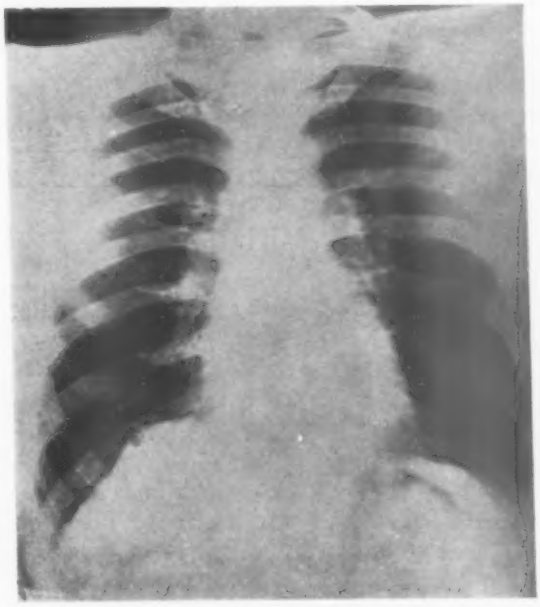

FIG. 3. Same, four months later. There is no deviation from the normal in the lung fields.

On the basis of the clinical findings and the roentgen examination, a diagnosis of massive collapse of the right lung was made.

On the sixth day after operation, temperature was 101.2°F., pulse 94, respirations 25; on the following day, the temperature was 98.8°F., pulse 85, respirations 25, and the patient was markedly improved clinically with much less cough. *X*-ray examination at this time (Fig. 2) also showed a marked change for the better. There was still diminished radiance over the entire right side, but it was much more mottled in character and there was evidence of beginning expansion of the lung. The heart and trachea were displaced to the right, but much less so than at the first observation. The right diaphragm could be seen faintly; it appeared high and its respiratory excursions were markedly limited. On the left, the findings were practically unchanged.

The patient continued to improve. On the eighth day after operation, temperature was 98.8°F., pulse 90, respirations 22; three days later, temperature, pulse and respirations were normal, there was no cough and he felt perfectly comfortable; at this time, the lung had apparently expanded and the heart and trachea had resumed their normal positions.

About four months later, the patient was requested to return for examination. His chest was examined carefully by two clinicians and found to be entirely negative. *X*-ray examination of the chest (Fig. 3) showed no deviation from the normal in the lung-fields, diaphragm, heart, or the position of the trachea.

COMMENT

This discussion and report of a case of massive collapse of the lung have been presented, not merely because of the comparative rarity of this condition, but rather because of their interest and importance to the surgeon, the clinician and the roentgenologist. The surgeon should be aware of the possibility of massive collapse so that he may realize that he is not dealing with a postoperative pneumonia, embolism, or similar serious complication. Massive collapse is rarely fatal, the prognosis being good except in cases with very extensive bilateral collapse, or those in which severe sepsis sets in. Since the clinician is frequently called in consultation in cases of pulmonary complications after operation, he must always bear in mind the possibility of massive collapse. As Bradford emphasizes so strongly, this condition has been confused with pneumonia, cardiac disease and other pulmonary or pleural lesions such as abscess of the lung; and such erroneous diagnosis may lead to methods of treatment which are not only unnecessary, but sometimes positively dangerous to the welfare of the patient; as for example, exploratory thoracotomy. The roentgenologist, too, should be on the watch for cases of massive collapse, for the *x*-ray picture is so typical

that an erroneous diagnosis on his part is hardly excusable.

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THE EFFECT OF X-RAYS ON BONE MARROW*

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THE action of *x*-rays on bone marrow was undertaken experimentally as part of an investigation started by two of us to determine whether certain chemical and physical agents have the property of stimulating bone marrow. Through the use of intra-vitam bone-marrow puncture as described by Morris and Falconer[1] it is possible to secure fresh specimens of bone marrow from the living animal and to study directly the effect of chemical and physical agents on the marrow. Such direct study is satisfactory within certain limits and enables one to make repeated observations, at stated intervals, on the same animal.

We were unable to find any published accounts with definite experimental evidence as to whether or not *x*-rays are capable of stimulating bone marrow. Considerable experimental work has been done on the effect of *x*-rays on the developing ovum and embryo. The earlier experiments were performed by Perthes[2] who found that exposure of the ova of Ascaris megalocephala to *x*-rays resulted in delayed development and the production of abnormal forms. In 1904 Gilman and Baetjer[3] observed temporary stimulation after radiating the ova of Amblyomma but the result was a fairly constant type of developmental defect. Bordier[4] in 1905, exposed young larvae of the common silk-worm to *x*-rays and found inhibitory effects in their development. Later work is that of Colwell, Gladstone and Wakeley,[5] who observed the action of repeated doses of *x*-rays upon the developing chick embryo. They conclude that embryos irradiated immediately before incubation and then subjected to daily exposures for several days were invariably smaller than the controls. The effects seemed to depend on the total amount of radiation reaching the embryo rather than upon its quality or "hardness." Some of their experiments seemed to indicate that embryos allowed to develop normally for ninety hours, then exposed to *x*-rays for three successive days, produced, in some cases, a certain degree of stimulation, as indicated by a slight increase in size. We have been interested in the studies of Ivy, Orndoff, Jacoby and Whitlow[6] on the effect of *x*-rays on glandular activity. Broadly stated, their results indicate that small doses of *x*-rays do not stimulate or sensitize the submaxillary gland to increased secretion. They also found that large doses of *x*-rays cause an immediate depression of the secretory activity of the gland, which they state may be due to an altered blood flow through the gland.

These experiments bear on our problem only in so far as there may be a similarity between rapidly growing embryonic cells whose chief function is to proliferate and the cells of the bone marrow which have a like function. We know, however, that other agents besides *x*-rays will produce

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arrest of development and abnormal types in the embryo. Abnormal temperature changes, treatment by many chemicals, lack of oxygen supply, or too much carbon dioxide, nutritional changes induced by feeding of thyroid gland and pituitary gland substances, all may produce marked changes in the developing embryo. We do not know what the effect of these agents is on normal adult bone marrow, but it seems, reasoning from analogy, that agents causing retardation or acceleration of division and growth of embryonic tissue, might similarly affect bone marrow, a tissue which probably retains its embryonic property of division and rapid growth.

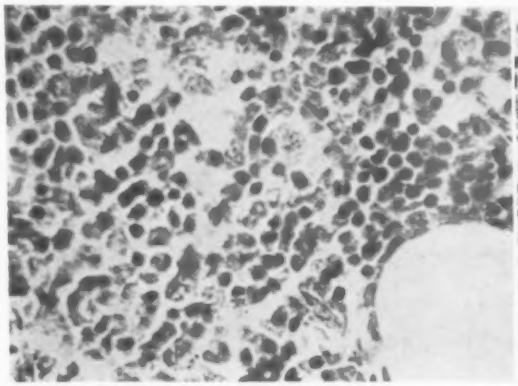

FIG. 1. Portion of left rib one week after heavy dosage of *x*-rays (control side).

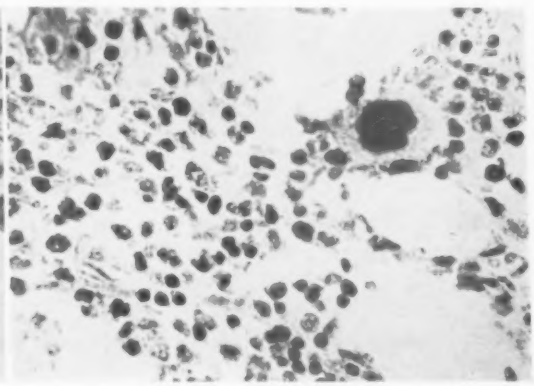

FIG. 2. Portion of right rib one week after heavy dosage of *x*-rays (radiated side). Difference in appearance between Figures 1 and 2 is due to the fact that sparsely cellular fields were selected for these microphotographs.

One question of importance in this study is whether or not it is possible to supply a stimulus to increased marrow cell production, other than the physiological stimulus of a need for more cells, such as comes from blood loss or blood-cell destruction. There are physical and chemical agents capable of irritating and destroying bone-marrow cells, as is seen in benzol poisoning and with radium emanation, when applied in close approximation to bone marrow. The specific points which these experiments seek to furnish data on are:

1. Will small doses of *x*-rays applied locally over a bone irritate the contained marrow cells and cause division and proliferation to proceed at a rate beyond normal?

2. Will large doses of *x*-rays applied locally over a long bone cause the contained marrow cells to undergo necrobiotic changes with resultant depression of the function of division and proliferation so that less than the normal number of marrow cells will be present on examination, or will a normal marrow become replaced by a fatty, atrophic, marrow tissue?

3. Is it possible indirectly to influence or to stimulate the bone marrow to an increased production of marrow cells by applying *x*-rays over the spleen?

Our first experiments were performed on rabbits (large rabbits being selected). A large dose of *x*-rays was applied over the front leg, on the right side, with a small dose applied to the hind leg of the same side. The left front and hind legs were used as controls. These experiments were unsuccessful and fell short of their purpose for two reasons. First, it was impossible to perform repeated marrow punctures at frequent intervals, over a long period, without fracturing the bones punctured. Second, when the animals were sacrificed and the marrow examined, the long bones were found to be so markedly and uniformly cellular that it was impossible to judge with precision fine degrees of increased or diminished cellular activity.

Our subsequent experiments were performed on dogs of fair size and development, as the long bones of these animals are sparsely cellular and a fairly satisfac-

tory base line can be secured. The setting for the experiments was as follows:

Two dogs were used, one, designated as Dog 2244, an old male, lively and apparently healthy. The other, designated as Dog 1, was a young female, rather thin at the beginning of the experiments, and for some reason showing a fairly marked secondary anemia. The cause of this anemia we did not discover as we knew nothing of her antecedents. We felt that she was a good subject for our purposes, as her marrow was active and in a state

Chart No. 1. Experiment No. 1.

Days before and after X ray treatment.	Heavy Dosage X-ray Right Front Leg.				Control. Left Front Leg.				Light Dosage X-ray Right Hind Leg.				Control. Left Hind Leg.			
	Cells per field.	White Cell Series.	Red Cell Series.	Marrow Cell Series	Cells per field.	White Cell Series.	Red Cell Series.	Marrow Cell Series	Cells per field	White Cell Series.	Red Cell Series.	Marrow Cell Series	Cells per field.	White Cell Series	Red Cell Series	Marrow Cell Series
3 days before:	2-3	55	28	17	3-5	49	27	24	3-5	51	29	20	2-4	49	26	25
2 days after.	3-5	55	26	19	2-3	52	28	20	3-6	49	33	18	6-10	39	43	18
9 days after.	3-5	51	26	23	2-5	51	29	20	4-7	47	28	25	6-9	43	36	21
21 days after.	2-4	53	28	19	3-4	52	27	21	3-5	49	28	23	5-8	47	30	23

that should easily respond to a marrow stimulus. These dogs were kept in cages and fed on table scraps. As the experiments progressed, the diet contained an increasingly larger proportion of meat. The *x*-ray treatments were localized as nearly as possible over the humerus, where the designation front leg is used, and over the tibia and femur, where the designation hind leg is used. The marrow punctures were performed for the most part on the tibia, though a few were performed on the femur. When the front leg was the site of a marrow puncture, the humerus was used. Technique used for accomplishing marrow puncture is described by Morris and Falconer in the *Archives of Internal Medicine*, October, 1922, xxx, 485. The marrow obtained from the punctures was smeared uniformly on cover slips, which were then dropped into absolute methyl alcohol and stained by a combination, Jenner stain, counter-stained by Giemsa's stain. The smears were rather difficult to interpret as we had to adopt criteria for estimating increased or decreased marrow activity. These criteria were evolved from examining many marrow smears from normal dogs, and from dogs with rickets, in which the marrow is hyperplastic. In the end, we adopted two main standards to guide us in estimating marrow activity and lack of activity. These are the average number of cells per field, picking out in each smear the best fields, and the types of cells present in each smear. As to types of cells, we have roughly divided them in each smear into White Cell Series, Red Cell Series and Marrow Cell Series. Differential counts have been made on each marrow specimen, according to this classification. In the White Cell Series are included chiefly cells having from 3 to 6 and 7 lobes of the nucleus and resembling the polymorphonuclear neutrophile of the peripheral blood in possessing neutrophilic granular cytoplasm. These proved fairly easy to identify. The Red Cell Series include those cells with dark, basophilic cytoplasm, occasionally reddish tinted, with dark staining round nuclei. The smaller nuclei usually stain as a dense black or dark bluish mass, while

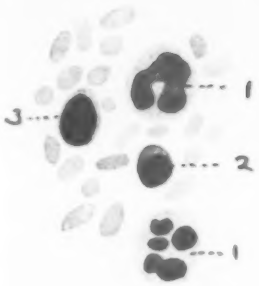

FIG. 1 Dog 26. December 8, 1922. Young normal dog. Bone marrow smear shows 2 to 3 cells to the field.

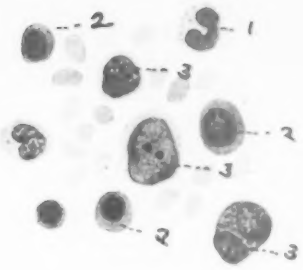

FIG. 2 Dog 33. December 6, 1922. Hyperplastic bone marrow from a young dog with Rickets.

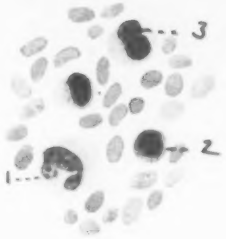

FIG. 3 Dog 2244. December 6, 1922. Right Tibia, before any exposure to X-ray had been attempted.

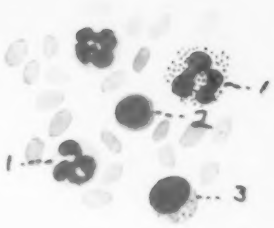

FIG. 4 Dog 2244. December 17, 1922. Right Humerus, treated side, nine days after heavy dose of X-ray.

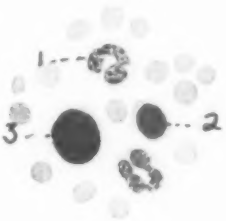

FIG. 5 Dog 2244. December 17, 1922. Right Tibia, treated side 9 days after light dose of X ray.

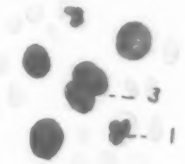

FIG. 6—Dog 1. July 9, 1923. Right Tibia, exposed side During repeated exposure to small doses of X-ray.

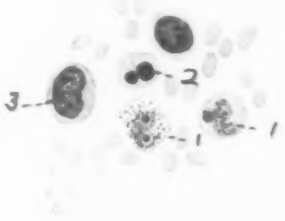

FIG. 7—Dog 1. July 9, 1923. Left Tibia, control. During repeated exposure to small doses of X-ray.

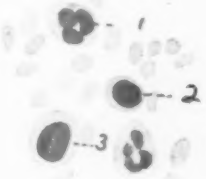

FIG. 8 Dog 2244. March 1, 1923. Left Tibia before X-ray exposure over spleen.

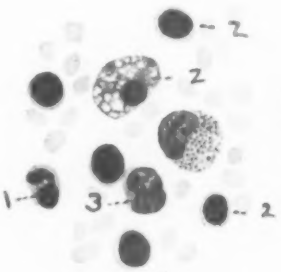

FIG. 9—Dog 2244. March 15, 1923. Right Tibia, 12 days after exposure of spleen to X-ray.

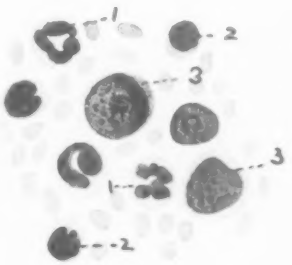

FIG. 10—Dog 2244. April 21, 1923. Right Tibia, smear taken during course of exposure over spleen. (weekly small dosage of X-ray).

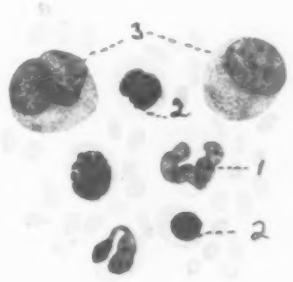

FIG. 11 Dog 2244. May 19, 1923. Left Tibia, 9 days after last exposure of spleen to X-ray (light dosage).

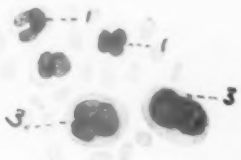

FIG. 12 Dog 2244. June 16, 1923. Left Tibia, 35 days after last exposure of spleen to X-ray (light dosage).

1. *White cell series.*
2. *Red cell series.*
3. *Marrow cell series.*

Drawings by Ralph Sweet

the larger nuclei exhibit masses of dark staining chromatin bunched around the periphery, the center of the nucleus being more open, with fine interlacing strands of chromatin running through. Some of these larger nuclei closely resemble rosettes. The marrow cell series include the larger cells with large round or oval nuclei "open-faced," with knots and bunches of chromatin scattered through, and varying amounts of pale blue homogeneous cytoplasm. Many of these cells show what appears to be direct division of the nucleus into two and sometimes three distinct nuclei. Cells of this type with granules in the cytoplasm were classed under the White Cell Series. These marrow cells are very interesting and merit a much fuller description, which cannot, however, be attempted in this communication.

Chart No. 1 Experiment No. 2.

	Irradiated Leg. Right Hind Leg.				Control Leg. Left Hind Leg.			
	Cells per Field	White Cell Series	Red Cell Series	Marrow Cell Series	Cells per Field.	White Cell Series	Red Cell Series	Marrow Cell Series
Before treatment.	8-10	25	40	25	10-12	27	40	33
5 days after.	7-10	34	32	34	8-10	20	53	27
12 days after.	7-8	48	26	26	8-10	30	31	39
18 days after.	6-8	47	34	19	8-10	45	35	20
26 days after.	5-7	51	33	16	6-9	55	30	15
40 days after.	3-5	45	30	25	8-12	40	32	28
46 days after.	5-8	60	20	20	6-9	55	28	17
60 days after.	5-6	55	25	20	6-8	50	21	29
75 days after.	3-5	55	24	21	8-10	58	22	20
92 days after.	3-5	54	20	26	6-9	50	30	20

EXPERIMENT NO. I

Exposure of Long Bones to Large and Small Doses of X-rays, in the Same Animal

Dog 2244. Preliminary blood counts were made on Dec. 1, 1922 and on Dec. 5, 1922. A bone-marrow puncture was performed on right and left front legs (humerus) and on right and left hind legs (tibia). On Dec. 8, 1922, *x*-ray exposures were made as follows:

	Distance in.	Filter Aluminum mm.	Milliampere min.
Right front leg (inner aspect, over humerus)....	12	9	250
Right hind leg (inner aspect, tibia and femur)..	12	9	50

The left front leg and left hind leg were carefully screened and used as controls.

We attempted in this experiment to ascertain the immediate effects of exposure of the marrow of long bones to both large and small doses of *x*-rays. The only portion of the marrow showing an increased number of cells in the smears obtained was the left hind leg, the control side for the limb receiving the small dose of *x*-rays. We have no satisfactory explanation for this. The point will be discussed later. Blood counts during the period of this experiment are shown in Chart No. 6. As will be noted, there was no difference between the effects of the light and heavy dosage, neither exposure seeming to influence the number of cells present.

EXPERIMENT NO. 2

The Immediate and Remote Effects on the Marrow of a Heavy Dose of X-rays over a Long Bone

Dog 1. On Dec. 30, 1922, a blood count was made and a marrow puncture performed on right and left front legs and right and left hind legs. The right front leg (humerus) showed 2–3 cells per field and left front leg (humerus) showed 3–6 cells per field. The front legs were not used again during the remainder of the experiment, the left hind leg alone serving as the control. On Jan. 9, 1923, the following *x*-ray exposure was given over right tibia, inner aspect.

	Distance in.	Filter Aluminum mm.	Milliampere min.
Right hind leg.....	12	9	480

At the beginning of this experiment, the bone marrow of this dog (No. 1) was somewhat hyperplastic as there was a secondary anemia present. The relative low percentage of the White Cell Series and the increased percentage of Red and Marrow Cell Series is undoubtedly explained by this fact and is not to be attributed to the effects of *x*-ray exposure. In this experiment again, it will be noted that the left hind leg (control) was slightly more cellular throughout than the exposed side (right). The effects in this case could scarcely be attributed to *x*-rays as it will be seen that there were more cells in the left leg specimens before treatment.

As a check to this experiment, Dog 1 received a heavy dose over four ribs on the right side of the chest. The left side of the chest was used as the control. Exposure was as follows:

	Distance in.	Filter Aluminum mm.	kv.	Milliampere min.
Tangent to right chest (ribs) at apex of black spot. Left covered.....	16	9	100	630

At the end of one week, a piece of rib was resected from the right (exposed) side and from the left (control) side. These specimens were decalcified and sectioned. The sections were stained by the eosin-hematoxylin and Jenner-Giemsa method. The sections had to be cut too thick for satisfactory study. It is difficult to estimate changes in the marrow of flat bones, as it is so cellular that unless the changes are marked there is no base line for comparison. We looked for evidence of cell necrosis such as dense staining of the nuclei, pyknotic nuclei, vacuolated, poorly staining cytoplasm, etc. We also searched for evidences of mitosis and amitosis. As far as could be determined, at the end of one week, no changes had occurred in the rib exposed to a single large dose of *x*-rays. At the end of three weeks, the same procedure was repeated, a portion of a rib from the right and left sides of the chest was resected and examined as above detailed. We did not note any differences between the treated and the control side, nor any difference between these specimens and the specimens obtained two weeks before.

EXPERIMENT NO. 3

Effect on the Marrow of the Long Bones during and after Five Radiations over the Spleen: Small Doses

Dog 2244. Not used for experimental purposes for three months. Exposures to *x*-rays were given over splenic region, left half of upper abdomen, from front, as follows:

	Distance in.	Filter Aluminum mm.	Milliampere min.
3/3/23	12	9	50
3/10/23	12	9	50
3/17/23	12	9	50
After rest of one month:			
4/16/23	14	9	50
5/11/23	15	9	160

it will be observed that during this experiment the number of cells per field were increased above the numbers found in any of the other experiments, also the number of cells of the marrow series were slightly increased. This finding indicates a true hyperplasia, as the presence of immature marrow cells in a rising proportion is of more importance than the mere increase in the number of cells in the smear.

Chart No. 1. Experiment No. 3

X-ray Exposure Over Spleen.

	Right Hind Leg.				Left Hind Leg.			
Date of X-ray Exposure.	Cells per field.	White Cell Series.	Red Cell Series.	Marrow Cell Series.	Cells per field.	White Cell Series.	Red Cell Series.	Marrow Cell Series.
Before Exposure.	6-7	52	28	20	7-9	49	27	24
2 days after 1st exposure.	6-8	51	24	25	7-10	46	25	29
6 days after 2nd treatment.	16-18	38	30	32				
7 days after 3rd treatment.					12-15	50	20	30
Rest of 1 month. Then 5 days after 4th treat.	12-16	48	20	32				
20 days after 4th treatment.					11-13	48	24	28
8 days after 5th treatment.	10-12	45	26	29				
35 days after 5th treatment.					3-5	52	26	22

The results of this experiment would seem to indicate that it is possible to influence the marrow of the long bones by radiation over the spleen. The dose of *x*-rays best suited to this purpose, the frequency of application and the time interval required to obtain the optimum results still remain to be worked out. By consulting Chart No. 1, Experiment No. 3,

EXPERIMENT NO. 4

Immediate Effect on the Marrow of the Long Bones of Repeated Small Doses of X-rays

Dog 1. No *x*-ray radiation for five months and nine days. Animal in good general condition. Treatments applied to inner aspect right hind leg directed to middle two-thirds of tibia.

	Distance in.	Filter Aluminum mm.	kv.	Milli-ampere min.
June 18/23	12	9	100	30
June 20/23	12	9	100	30
June 22/23	12	9	100	30
June 25/23	12	9	100	30
June 27/23	12	9	100	30
June 29/23	12	9	100	30
July 2/23	12	9	100	30
July 6/23	12	9	100	30
July 9/23	12	9	100	30
July 11/23	12	9	100	30
July 13/23	16	9	100	30
July 16/23	16	9	100	30
July 18/23	16	9	100	30
July 20/23	16	9	100	30

Changes in the Formed Elements of the Peripheral Blood During *X*-ray Radiation Experiments

Dog 2244. The only changes to be noted in the blood picture of this animal are a gradual increase in the percentage of hemoglobin. Between June 2, 1923 and June 16, 1923, an interval of two weeks, his blood count rose about one million cells. This was thirty-five days after the last radiation over the spleen. The most important finding in this series of blood counts is the increase in platelets which became apparent after instituting *x*-ray treatments over the spleen. This animal is

Chart No 1. Experiment No. 4.

		Irradiated Leg. Right Hind Leg.				Control. Left Hind Leg.			
		Cells per field.	White Cell Series.	Red Cell Series.	Marrow Cell Series.	Cells per field.	White Cell Series.	Red Cell Series.	Marrow Cell Series.
Frequent small doses to right hind leg. 3 treatments per week.	Before X-ray Exposure.	3-5	50	29	21	5-8	52	30	18
	1 week after.	3-5	50	31	19	5-8	48	28	24
	3 weeks after.	4-7	54	26	20	5-7	52	29	19
	7 weeks after.	4-6	52	28	20	3-6	52	29	19

A study of Chart No. 1, Experiment No. 4 shows practically no increase in number of cells or change in the relative percentages of the different types. The examinations of the marrow were made up to seven weeks after the first radiation and twelve days after the last. It is important to know what the remote effects of frequent small doses would show in the bone marrow, as this question has arisen in connection with the aplastic type of anemia which has occurred in roentgenologists.

an old dog and showed at the beginning a rather low platelet count which rose and maintained a higher level after the radiation over the spleen. The method used for platelet counting was Gram's modification of the Thomsen method.[7] This finding should be checked up by a larger series of carefully controlled experiments. The reticulated red cells were very little influenced by the *x*-ray radiation.

Dog 1 shows a gradual increase of both hemoglobin and red cells during the

experiments. This is probably accounted for by the fact that this animal was anemic at the beginning of the experiments, and during the experiments was on a diet conducive to and under conditions favorable for blood regeneration. This regeneration was probably carried on chiefly in the marrow of the flat bones and was only slightly reflected in the marrow of the long bones. The weight and general condition of the animal improved markedly during the period of the experiments. The total gain in weight was 5 lbs.—from 35 to 40 lbs. There is no clear evidence that the *x*-ray radiation of the long bones brought about the increase in red cells and hemoglobin through irritation or stimulation of the bone marrow, not detectable in the examination of the bone marrow smears. Had this been the case, we feel that the number of reticulated red cells would have been higher throughout. It will be noted that the platelets remained at about the same level throughout. The white cells and the relative percentage of different types of white cells showed no changes in either animal that we regarded as having any particular significance.

Chart No. 5

BLOOD COUNTS — DOG 2244.

	Date.	Hgb.	R.B.C.	W.B.C.	Differential.						Platelets	Ret. Rs.
	Before X-ray.	%			PMN. %	PMN %	PMN %	L. %	LM & T %	%		%
	12/1/22	99	7,605,000	8,100	66		10	21	3		180,000	
					Occ. cell shows diffuse stippling.							
Irradiation over right front and right hind leg.	12/11/22	98	6,980,000	8,400	76		2	18	4		131,872	
	12/17/22	100	7,079,000	9,700							133,264	
	12/20/22	98	7,040,000	12,600	76		6	13	5		124,680	
					Many cells show diffuse stipp. Turck.							
	12/23/22	95	6,450,000	13,000	66		2	23	7	I.P. 2	156,879	
					1 normoblast - many show dif. stipp.							
	1/1 /23	98	6,810,000	7,300	63		3	25	9	Myel.2		2.5
					Few cells show diffuse stippling.							
	3/3 /23	105	7,150,000	10,200	63		10	21	6		328,000	2.
	3/9 /23	110	6,860,000	10,000	77		5	17	6		310,000	1.6
	3/15/23	110	7,140,000	8,200	67		4	21	8		180,960	Less than 1
	3/18/23	110	7,000,000	9,000	74		7	13	6		356,000	1.
	3/22/23	110	7,120,000	8,200	79		2	13	6		320,000	1.
	3/31/23	115	7,140,000	8,400	69		4	19	8		392,000	1.3
Irradiation over spleen.	4/5/23	110	6,950,000	10,200	72.5		4.5	13	8	Myel..5	260,000	1.3
	4/14/23	110	7,320,000	7,600	54		1	40	5		240,000	1.2
	4/19/23	115	7,010,000	7,600	75		5	15	5			
	5/7/23	120	7,400,000	9,700	73.5		1.5	20	5		258,000	1.8
	5/10/23	120	7,230,000	9,000	65		4	24.5	4.5		362,000	1.7
	6/2 /23		7,360,000	8,400	73		8	16	3			1.5
	6/16/23		8,340,000	9,400	69		4	22	5		312,000	2.2

Ret. Rs - Reticulated Reds. Myel. - Myelocytes. Turck I.P. - Turck Irritation form.
Dif. stipp. - Diffuse stippling.

SUMMARY AND DISCUSSION

Four series of experiments were performed bearing on the effect of *x*-rays on bone marrow. The data secured from Experiments 1, 2 and 4 indicate that varying doses of *x*-rays have little or no effect on the bone marrow of long bones when applied directly over these long bones. This would be evidence against the practice of treating the leucemias by *x*-radiation over the long bones. One must take into consideration, however, that these experi-

ments deal with marrow practically in a normal state of balance, while in the leucemias the marrow is in an abnormal state and filled with large numbers of immature cells. The same reasoning applies to the treatment of polycythemia over the long bones. The question of the reaction of pathological bone marrow to *x*-radiation may be entirely different from that of normal marrow. The results of Experiment 3 are suggesting *x*-radiation of the spleen occur as the result of bone-marrow depression and consequent decreased cell production, or do they occur as the result of leucemic cell destruction followed by a stimulation of the normal elements of the marrow? Such stimulation might result in increased proliferation of red cells and the normal types of marrow cells, restoring for the time the normal bone-marrow balance and inhib-

Chart No. 6

BLOOD COUNTS -- DOG 1.

	Date.	Hgb.	R.B.C.	W.B.C.	Differential						Platelets	Ret. Rs.
	Before X-ray.				PMN %	PNS %	PNS %	L. %	LM & T. %			%
	12/30/22	105%	5,690,000	8,700	64	1	13	16	6			
Expo-	1/3/23	90	5,650,000	15,100	80		2	12	5	Myel. 1	264,928	
sure	1/9/23	90	5,170,000	8,100	75		2	18	5		223,040	
over	1/14/23	98	6,430,000	9,000	63		2	25	10		248,000	
right	1/21/23	102	6,300,000	9,600	71		4	17	7	Turck. I.F. 1	240,000	
hind	1/27/23	105	6,410,000	8,000	73	1 normoblast seen. Cells show dif. stipp.		6	15	6	325,000	4.1
leg.	2/ 3/23	106	6,520,000	10,900	74	Many cells show dif. stipp. Turck.		5	12	8	I.F. 1 384,000	3.6
Heavy	2/10/23	112	6,500,000	9,400	70			8	13	9	303,328	3.2
dose.	2/16/23	110	6,400,000	7,200	75			6	16	3	215,232	2.
	2/23/23	130	7,360,000	8,400	80			5	11	4	248,000	2.3
	3/ 9/23	115	7,180,000	8,600	76.5	.5	9	10	4		244,000	2.
	4/11/23	125	7,210,000	10,500	75		3	16	6		268,000	1.1
	5/30/23	120	9,450,000	8,200	63		13	20	4		344,000	2.4
Pre-	6/23/23	125	8,020,000	8,600	69		8	17	6		312,000	1.9
quent	7/8/23	120	9,220,000	6,900	66		6	25	3		190,000	1.3
small	7/14/23	118	8,740,000	8,600	63.5		6	27.5	3		264,000	1.8
doses	7/22/23	122	9,330,000	9,400	68		5	23	4		225,000	2.2
X-ray	over right hind leg.											

gestive and raise the question of the possibility of influencing the bone marrow much more readily through *x*-ray applied over the spleen than through direct application over the bones themselves. It is possible that radiation over the spleen by exposing the blood cells directly to the action of the *x*-rays results in increased blood destruction, and the products of destroyed and disintegrated blood cells may directly stimulate the bone marrow. The question arises here as to whether or not it is possible to depress the bone marrow through large doses of *x*-rays applied over the spleen. For example, do the lowered blood counts in the leucemias following the production of the immature leucemic cell. Until we know more about why the spleen may at one time destroy large numbers of red cells, as in the hemolytic icterus anemias, and at other times proliferate large numbers of white cells, as in myelogenous leucemia, it will be difficult to work out methods of influencing bone marrow in a constructive way through the spleen. There is an increase in the cells of the marrow on the control side in Experiments 1 and 2 which might suggest that *x*-radiation of one portion of the marrow is able to cause a proliferation in some other portion of the marrow. It will be noted in the charts accompanying these experiments,

that the cells per field in the left hind leg (control side) are uniformly a little higher than in the treated side. This loses its significance, however, when we note that the smears taken before any *x*-ray applications were made showed more cells on the left than the right side.

CONCLUSIONS

1. Direct *x*-radiation of the long bones of the dog, in both light and heavy dosage, did not appreciably stimulate or decrease the contained marrow cells.

2. Repeated small doses of *x*-rays over the spleen caused a slight increase in the number of cells in the marrow of the long bones (right and left tibia) of the dog; also there was noted an increase in the proportion of immature marrow cells.

3. *X*-radiation over the spleen produced a rise in the number of platelets in the peripheral circulation, which rise was maintained during the experiment.

4. The general condition of both animals was improved during the experimentation and the hemoglobin and red cells increased. No untoward effects were noted as a result of frequent bone-marrow punctures.

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A ROENTGEN-RAY STUDY OF THE LA BREA (CALIF.) FOSSILS

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NOWHERE in the literature have I found a roentgen-ray study of any prehistoric pathological bones and I therefore thought a careful examination of the large collection of La Brea fossils might yield some interesting facts. These bones are really not fossils in the sense that part of the bone is dissolved out and replaced by silicates which are opaque to the roentgen ray, but are the result of an unusual means of preservation by crude oil and asphaltum. Few specimens other than those preserved in asphaltum have been roentgenographed. Out of a considerable number of elephant teeth and femurs removed from local sand-pits only one gave a satisfactory roentgenogram. A portion of this tooth had been dissolved out and not yet replaced with silicates.

The La Brea Collection at the Los Angeles County Museum is probably one of the largest collections in existence of prehistoric bones (there are over 1,000 complete skeletons of saber-tooth tigers and nearly as many of prehistoric wolves) but even in this number there is a surprisingly small percentage of pathological specimens and most of these are healed fractures. About one hundred pathological bones have been examined in this preliminary survey. Most of the bones are of animals larger than the fox; the bones of the smaller animals were probably crushed and eaten by the jaws of such powerful carnivora as the wolves and lions.

After being boiled in kerosene for one hour to free the specimens of crude oil they resemble bones that might be found in some forgotten corner of any anatomical laboratory, varying in color from black to light brown and are very light in weight. Many of the bones are fragile and all of

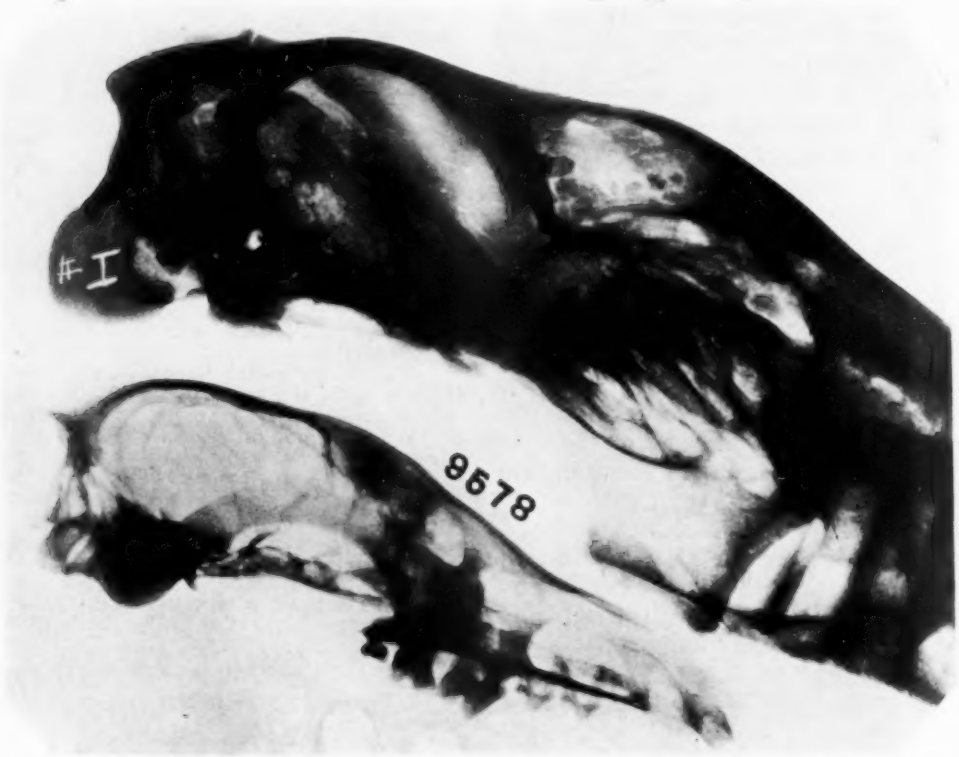

FIG. 1. Lateral half of skull of extinct ground sloth (Nothrotherium shastensis) which existed in large numbers during the Pleistocene period. The size of the brain was no larger than that of the extinct coyote shown below it, an animal at least ten times smaller in size. It relied chiefly on its giant claws which were both weapons of defense and powerful digging tools. The hide was studded with many scutes, very hard bony concretions as much as one-half inch in thickness, which were arranged in several layers, much like the steel disks in a Lee auto tire, thereby making it puncture proof as far as the saber-tooth tiger and other carnivora were concerned. The pathology in this skull is in the frontal sinus where several calcified nodules are present.

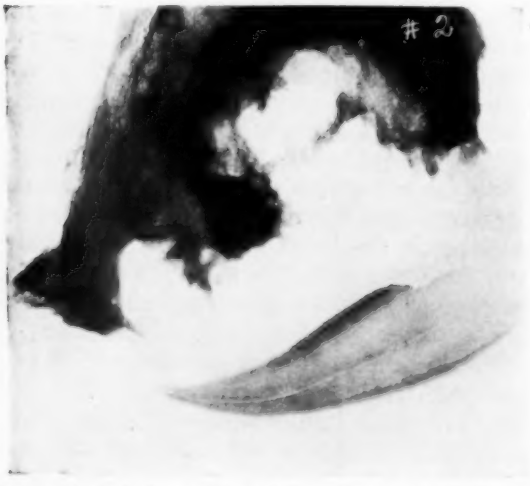

FIG. 2. Acetabulum of the saber-tooth tiger showing the destructive (tuberculosis) type of bone lesion. Beneath this is the temporary (saber) tooth of the tiger.

them very valuable, therefore the early work was done at the museum with a small portable outfit. However, in the study of the teeth of prehistoric elephants which are 6 in. in the narrowest diameter and of the same density as human teeth, long exposures on a 10 in. spark-gap with double screens are necessary. For all teeth and large bones the Bucky diaphragm is absolutely essential. Another difficulty is the removal of fine sand particularly in skulls, these are usually sawed in two so that they can be properly cleaned.

The lesions resulting from infection have been the first for observation. Unfortunately there is very little written from the roentgen-ray standpoint on the lesions of present day animals but the museum has diseased bones of modern animals and these were used for comparison.

Mr. J. W. Lytle of the osteological department of the museum broadly classifies these prehistoric lesions in two types, the productive and the destructive.

The destructive type somewhat resembles the lesions produced by tuberculosis of to-day. Tuberculosis is the only disease affecting practically all modern animals, including fish. History tells us that tuberculosis of animals was recognized as far back as the time when the Jews were captives in Egypt at which time they had several ecclesiastical laws forbidding the use of flesh from animals afflicted with tuberculosis.

The productive type resembles no particular present day type of infection. The bones, however, of a kangaroo obtained from the Seelig Zoo showed changes resembling the type observed in the saber-tooth tiger. Practically all bones of the kangaroo were affected, apparently a marked hypertrophic arthritis.

Whether the action of bacteria or the reaction of tissue to them was different in prehistoric times is of course difficult to answer, since the bacteria of that time may be extinct as well as their hosts. The non-motile, anaerobic, spore-bearing bacteria of to-day existing under rather wide ranges

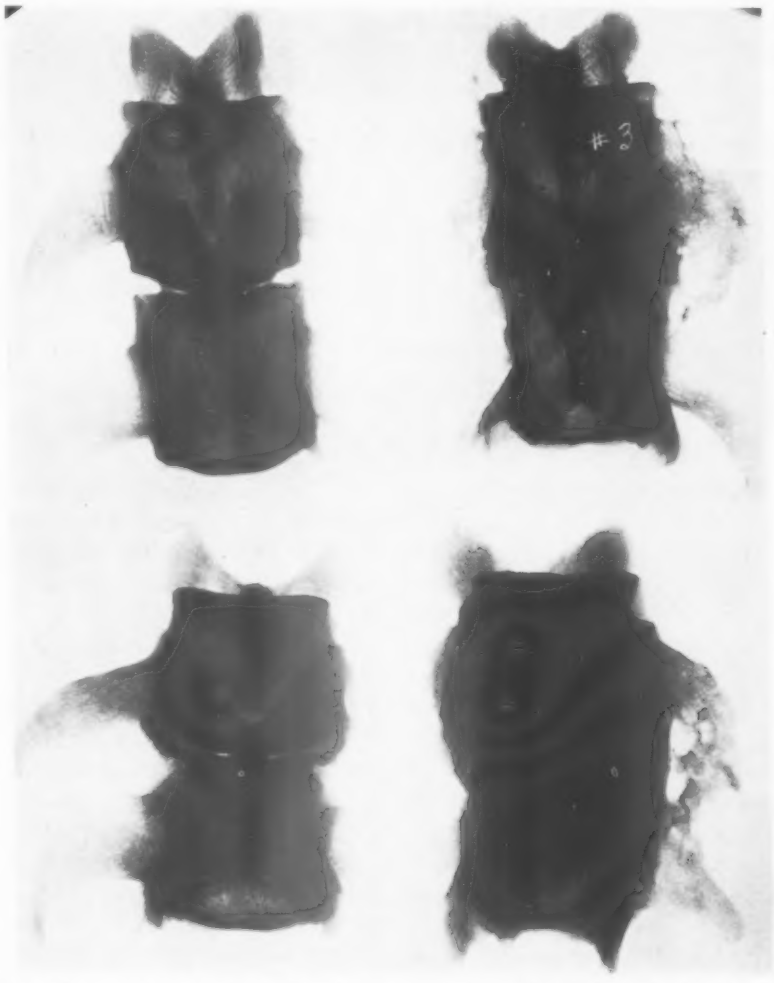

FIG. 3. Illustrates one method of study by comparison of pathological saber-tooth tiger vertebra with the normal of the same species and age. This is the productive type of bone lesion.

of temperature may be the result of evolution under adverse conditions and therefore the method of attack on tissues may be greatly altered.

At present the most that can be said is that the destructive type of prehistoric bone lesion somewhat resembles tuberculosis.

No study of the fractures has been made and no bone tumors were found. One interesting thing noted was that fossil fish imbedded in chalk, such as is found at Lompoc, California, can be roentgenographed in pieces nearly a foot thick with the aid of the Bucky diaphragm. Plates made at right angles to each other will save much tedious labor in preparing these specimens because the preparator will be able to localize objects sought, and quickly remove superfluous parts without damage to the specimen. Several other minor things of this nature were discovered and I am sure the roentgen ray can be used in this branch of Science to advantage.

The above is a preliminary survey and the subject will be more fully dealt with at a latter date.

DIVERTICULA OF THE STOMACH*

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IT may seem strange to you to speak on diverticula of the stomach, a condition which all writers have agreed to be a rare one. There is little in the English literature on the subject, more in the German literature; but all of it is rather poorly defined. Alexis Thompson[1] in 1910 went so far as to write that, "in the stomach diverticula are so rare as to be of little or no clinical importance." However, I was led to read up the subject after the finding of 2 cases of diverticulum of the stomach by roentgen ray. It is of importance for a roentgenologist to know something of the subject since he is the one who will make the diagnosis. The question of an operation will depend in many instances upon his interpretation of the roentgenographical findings.

A diverticulum is defined as "a pouch or pocket leading off from a main cavity or tube." These are divided into two types; the false and the true diverticulum. The false diverticulum is "an intestinal diverticulum due to the protrusion of the mucous membrane through a tear in the muscular coat" and the true diverticulum is "an intestinal diverticulum formed by the protrusion of the entire intestinal wall." In addition to this classification, diverticula are also spoken of according to their supposed etiology. In the case of esophageal diverticula, pathologists recognize two types; namely, those due to pressure, in which case it is thought that the force exerted by large boluses of food distend a weak spot in the wall and cause a bulging; and those cases due to traction in which inflamed structures become adherent and cause a tugging on the esophagus with a resultant pocket.

Strictly following the definition of a diverticulum, any outpocketing from the stomach as shown by giving barium to a patient should be spoken of as a diverticulum and we should have to include as such every case of a penetrating ulcer. However, no one considers the so-called Haudek's niche in this category. But we do have to consider the ruptured gastric ulcer which has become walled off, and we must attempt to differentiate it from pockets due to other causes. Boreszeky[2] has discussed his phase of the matter and reports 2 cases.

* Read before THE NEW ENGLAND ROENTGEN RAY SOCIETY, May 4, 1923.

However, Heubel[3] has reported a case of gastric ulcer, which had caused a traction diverticulum and which later became adherent to the pancreas and formed a communication with the duct of Wirsung. Another case of a traction diverticulum is one that Tilger[4] discovered at postmortem. This was situated at the pylorus and was the result of adhesions to an old thickened gall-bladder. During life the patient had had no symptoms referable to the condition. Zahn[5] has also reported a case in which he could not decide whether the pouch was due to traction or to pressure.

As a matter of fact, the only case of a gastric diverticulum definitely due to pressure was one reported by Schulten[6] in which the patient had a large hair ball which had caused a local dilation.

Besides those just enumerated there have been several cases recorded in which no cause was given.[7,8,9,10,11]

But the cases which are the rarest and which interest us most are those of congenital origin. At one time it was thought that the true diverticula were congenital in origin. Thompson,[1] however, says that "the demonstration of acquired pouches in which all the coats are represented has made this distinction invalid and we now speak of congenital diverticula in which the protrusion depends on the persistence of fetal structures such as the vitelline duct." Zahn[5], writing in 1899, said that no congenital gastric diverticula had been observed up to that time. In 1908 Thompson[1] said that "a few specimens are recorded in which the stomach has presented one or more congenital pouchings which have been compared to the compartments of the stomach met with in ruminants." The only other instances recorded are those of minute diverticula in the vicinity of the pylorus associated with the presence of an accessory pancreas.

In 1910 Keith[12] reported having found one in the College Museum in London, and one in the London Medical Schools. Both of them were at the cardiac end, which is of interest to me in that this is the position of the two I have seen. One of these he reports, arose just below and behind the entrance of the esophagus. The one in Guy's Hospital Museum was composed merely of mucous membrane and arose near the esophageal opening. Sternberg[13] says that a few cases have been described of congenital infolding of the stomach, whereby it has become formed into a greater diverticulum. Falconer,[14] in 1907, reported a case of what he considered to be a congenital diverticulum of the stomach and duodenum because the muscle coats were all intact and greatly thickened. In this case the normal mucous membrane was replaced, as he expressed it, by a glandular tissue of lobules composed of alveoli lined by polyhedral cells closely resembling those of the pancreas.

Glinski[15] who has written on the finding of accessory pancreas in the gastro-intestinal tract believed that they might be the cause of diverticula, and Nauwerck[16] has reported a case in which a definite accessory pancreas was found. But whether these cases can be classed assuredly as of congenital origin seems to be a little in doubt.

The 2 cases which we have had in the hospital emphasize satisfactorily the conditions and problems which this type of case presents.

Case I. (No. 703) D. F. first entered the hospital in January, 1914, complaining of "gas pains." Family history and past history were essentially negative. The present illness began thirteen years previously when the patient started to have pain in the right lower quadrant. A year later her appendix was removed with some relief for one year. Her abdominal distress then became gradually worse as the patient became gradually more constipated. Six years before entrance to this hospital a roentgenographical examination was said to show obstruction in the right iliac region and some adhesions were freed. One and a half years before entry the patient had an attack of pleurisy in the left chest and two weeks later she had a very sudden attack of pain in the epigastrium with tremendous distention, pain and cyanosis. The distention caused marked dyspnea and some delirium. This condition lasted for four hours and passed off gradually without treatment. Constipation and ab-

dominal distress increased steadily up till time of entrance. Physical examination was essentially negative. The patient improved under a constipation regime, so that she was discharged after a twenty-one day stay in the hospital with a diagnosis of constipation. The patient entered the hospital again eight years later in April, 1922. Since her previous admission she continued to be troubled with constipation and abdominal distress, and five years before her second admission to this hospital more roentgenograms of

FIG. 1. The connection of the diverticuulm does not show on the plate but was definitely made out fluoroscopically.

the gastrointestinal tract were taken, she was operated upon, and more adhesions were freed. Physical examination was again negative except for slight dulness over the apices of the lungs. Chest plates, however, reveale extensive tuberculosis. Roentgen studies of the gastrointestinal tract (#966) were as follows: "This stomach occupies a medium position with a normal peristalsis and tone. Just at the cardiac orifice there is a definite diverticulum about 2½ cm. in diameter on the lesser curvature side of the stomach. There was some barium remaining in this diverticulum at the end of six hours. The rest of the examination was negative." (Fig. 1).

The patient was then discharged to a sanatarium for treatment of her lung condition. A year later the patient returned to this hospital for a neurological condition and roentgenograms of her stomach showed exactly the same findings.

The question arises about this patient as to how long she has had this condition. Is this a congenital diverticulum like the cases reported by Keith? If so, it has been missed in several roentgen examinations. If it is not congenital when and why did she develop it? Could it have occurred at the

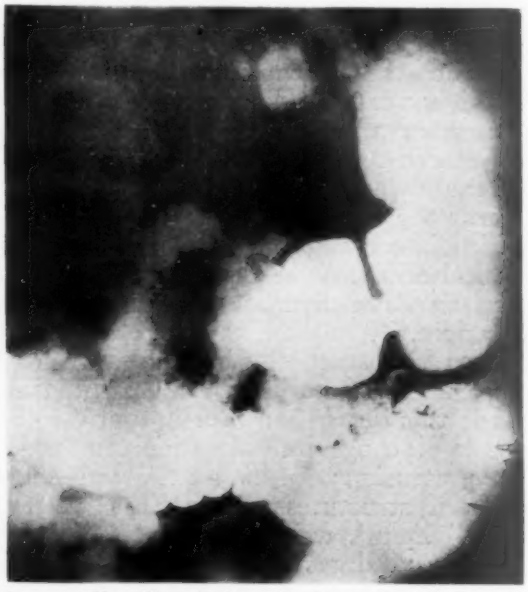

FIG. 2. The diverticulum is shown just below the esophageal opening. Its connection with the stomach shows fairly well.

time she had her severe epigastric pain associated with her pleurisy? But she has had a negative barium series since that time. We are not helped by her symptoms as they can all be explained on the basis of her other pathological findings. Finally, what are we going to do for it? Knowing so little about the condition it would seem best to do nothing until we have more definite information on the subject.

CASE II. (No. 19269). J. H. aged forty-eight, entered the hospital in August, 1922, complaining of "pain in the stomach." Family history, habits and past history are unessential. The present illness began fifteen

years ago with belching of gas after meals. Ten years ago the patient began to have a dull aching epigastric pain usually coming on at night with intermissions of several months. For ten weeks it has been radiating over the precordium. It is not definitely related to meals. However, after eating he often feels a sensation of burning fire beneath the sternum. Roentgen studies (#25891) of the gastrointestinal tract showed, "a constant projection from the lesser curvature of the stomach just below the cardiac orifice forming a circular protuberance about the size of a quarter with a narrow neck. The gastric outline was otherwise negative but the stomach showed vigorous peristalsis. The duodenal cap was small and rather constantly deformed in its first portion. Impression: Findings are strongly suggestive of duodenal ulcer. The projection noted above is thought to be a diverticulum from the stomach" (Fig. 2).

Here we have a patient whose symptoms can again be explained by pathology other than the diverticulum, and in view of our present knowledge we decided to do nothing about it.

For the present, then, the diagnosis of gastric diverticula has to be made by the roentgen examination for there are no characteristic symptoms so far as we know. In those patients with traction diverticula their symptoms, if any, are those found in any inflammatory condition with adhesions, and in all cases reported there has been enough other pathology to warrant all the symptoms complained of without having to consider the diverticulum per se. In the case of the patient with the hair ball the chief symptom was that of epigastric pain, and as there was a definitely palpable tumor in the right side the patient was operated on. Of the congenital cases, Falconer's had no symptoms, and the other cases had more pathology which could account for their history.

Therefore, without pathognomonic symptoms or signs one requires the roentgenographic picture of a sack communicating with the stomach in order to make a diagnosis. But even if one finds such a condition it is difficult, and at times impossible, to decide the etiology of the condition portrayed. Ulcer must be recognized by the secondary signs found in the roentgen ray; if these are wanting we must fall back on the patient's history. Thus if a patient has no secondary signs but has had at any time a history suggestive of ulcer, it is safest to make a diagnosis of an old penetrating ulcer merely by the law of chance; or if the patient has or has had a history which could be interpreted as inflammation with adhesions, it is best to focus one's attention on neighboring organs, such as the gall bladder; for it is doubtful if the gastric pouch is the primary condition. Of the cases in the literature there is no evidence to show that a congenital diverticulum of the stomach ever causes adhesions. The diagnosis of congenital diverticulum, therefore, rests on the presence of a gastric diverticulum as shown by roentgen ray with no evidence either by symptoms or signs to explain its presence.

Now granting a diagnosis of diverticulum has been made, what is one to do about it? From what has been said it would seem best to leave it alone. On the other hand Mayo[8] and Carman and Miller[17] have reported cases showing carcinoma, and Mellon[10] et al. reported a pedunculated diverticulum nearly opposite the cardiac opening of the stomach, the histology of which the authors felt could be diagnosed as precancerous. The latter writers are strongly of the opinion that gastrointestinal diverticula favor malignancy. As yet we have not enough evidence to warrant any definite conclusion, and we can lay down no definite rules for treatment. Each case must be considered individually.

SUMMARY

In this brief paper I have attempted to correlate as well as possible the literature on a condition which is very rare and about which very little is generally known. With the general use of the roentgen ray, we are occasionally going to see cases such as I have reported tonight, and we ought to have some idea as to what we may be dealing with. At the present time nothing is known concerning the symptoms which congenital diverticula may produce and we

have to rely on the roentgen ray to make the diagnosis. But if others will report such cases as they find them, we may be able to obtain some definite ideas concerning gastric diverticula.

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A CASE OF PNEUMOCONIOSIS WITH AUTOPSY FINDINGS

BY J. H. GREEN, M.D.

ROCHESTER, NEW YORK

DURING recent years occupational diseases have gradually assumed an importance which must be seriously taken into account in the differential diagnosis of diseases of the chest. In many instances findings in the chest that are otherwise unaccounted for are made clear by close attention to the occupational history of the patient. With this fact in mind I am taking this occasion to present a case of pneumoconiosis that we had under observation for some time.

J. P., an English stone cutter, aged thirty-eight, entered the sanatorium in August, 1919. He gave a history of cough for the past several months, with fever, and lassitude. He had expectorated blood one month previous to his admission.

Physical Examination. Right Lung: Breath sounds normal but there were a few rales at the apex and at the base, front and back. Left Lung: Few rales at the base, front and back

The roentgenogram showed a dense mottling throughout both lungs (Fig. 1).

The sputum was negative on fifteen examinations.

We diagnosed this case miliary tuberculosis. This diagnosis was made largely on the misinterpretation of the roentgenogram and partly on failure to go into the patient's history more thoroughly. The patient improved very much on sanatorium treatment and the diagnosis was changed to pneumoconiosis. He was then discharged, improved, in November, 1919, but was advised not to work as a stone cutter. This advice was disregarded after he had been at home several months. In consequence he again became ill and was readmitted to the sanatorium in April, 1922, with the following history: He had rested at home for twelve months and his health had been quite good. After this he had worked for eight months when his health gradually failed. The

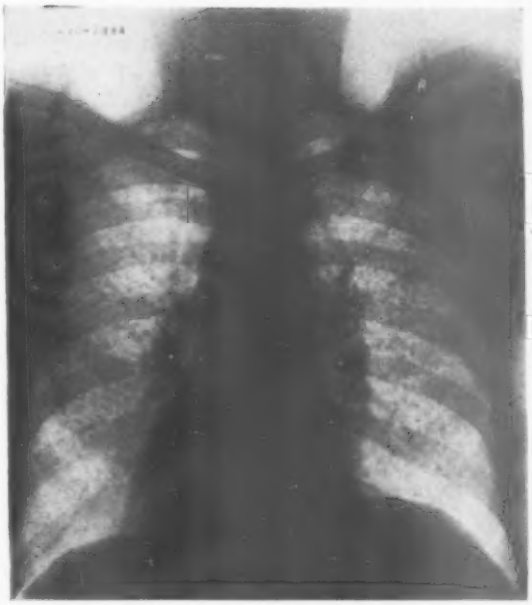

FIG. 1. Roentgenogram on admission showing dense mottling throughout both lungs. Appearance simulating that of miliary tuberculosis.

FIG. 2. Mottling throughout right lung and upper part of left lung with dense shadow lower half of left lung. This shadow on autopsy proved to be pyopneumothorax.

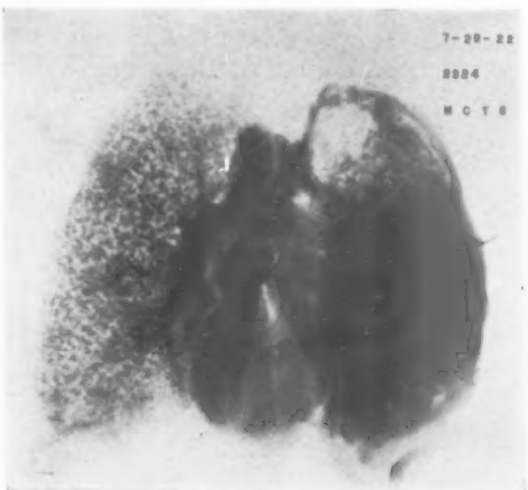

FIG. 3. Heart and lungs removed in toto, showing mottling of right lung and upper part of left lung. Lower left shows many cavities.

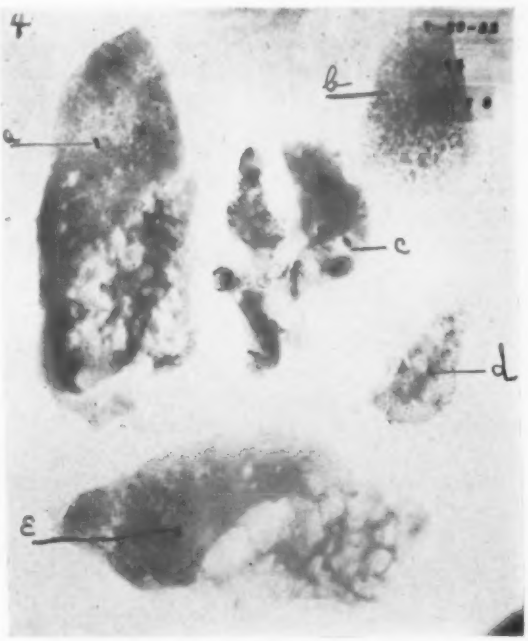

FIG. 4. Roentgenograms from sections of lungs. See page 360.

chief complaint was dyspnea. On readmission he had pain in his left side, a severe cough, expectoration, blood-streaked sputum and temperature 103° plus, almost every day.

Physical Examination. Right Front: An area of bronchial breathing at the level of the 3rd rib. Right Back: A small area of dullness near vertebrae at the level of the 5th and 6th vertebral spines, with a few rales.

Left Front: Dullness from the 4th rib to the base. Distant breathing at the level of the 4th and 5th ribs with absence of breath sounds 5th rib to base. Left Back: Dullness from the 4th rib to the base. Distant breathing from 5th to 8th dorsal spines with absence of breath sounds from the 8th dorsal spine to base.

The roentgenogram on the second admission showed dense mottling throughout the right lung; dense mottling upper half of the left lung, and a very dense shadow lower half of the left lung (Fig. 2).

The patient's temperature stayed around 103° each day. This was accompanied by a severe cough and very profuse expectoration, frequently tinged with blood. His general condition gradually grew worse and death occurred in July, 1922.

Roentgenograms were taken after death which showed practically the same as was shown in Figure 2. On opening the pleural cavity a pocket containing 500 or 600 c.c. of bloody pus was found at the left base. There was an opening from the lung into the pleural space (pneumothorax). The lungs and heart were removed and roentgenograms were taken which showed the same mottled appearance throughout the right lung and the upper part of the left lung as described above. The lower part of the left lung showed many cavities. Chains of glands could be seen extending down to each hilum—probably due to deposits of stone dust (Fig. 3). On section these glands gave a gritty sound against the knife. The lungs were sectioned and roentgenograms were taken as follows (Fig. 4):

(*a*) Longitudinal section of left lung with the lower part honey-combed with cavities.

(*b*) Section from the right apex showing the dense mottling described above.

(*c*) Section from the root of the right lung showing hard glands probably due to deposits of stone dust.

(*d*) Section from the root of the right lung showing a small piece of gland and mottling outside of root of the lung.

(*e*) Same as (*a*).

Dr. Dunham says: "A correctly interpreted roentgenogram is the most valuable aid in the differential diagnosis of diseases of the lung." One cannot lay too much stress on the phrase, "correctly interpreted." To follow this advice a history, including an occupational history, physical findings, roentgenological findings, and laboratory findings must each be accorded its proper valuation, giving one a solid foundation on which to base a diagnosis.

THE ROENTGEN DIAGNOSIS OF ANEURYSM OF THE AORTA*

ERNEST CHARLES SAMUEL, M.D.

Touro Infirmary

NEW ORLEANS, LOUISIANA

THE differential diagnosis of aneurysm of the aorta, dilated aorta and aortitis is quite difficult without the aid of the roentgen ray. The routine study of all chest and abdominal cases with the aid of the roentgenoscope will quite often reveal lesions of the vascular system that were not suspected at the time of the physical examination, no matter how carefully made. I emphasize the roentgenoscope because more information is to be gained from the actual visualization of the part under study and films are only made to confirm the shadow seen. The taking of a film in only the antero-posterior position is quite misleading and we should discourage this type of half-hearted examination which is seen only too often.

Unfortunately we have no absolute standard of measurements that are applicable in all types of individuals. The work of Vaquez and Bordet in France has gone a long step forward in establishing a working basis for these examinations. Observers differ, however, in the interpretation of shadows, so that what appears to be a dilatation to one is an aneurysm to another.

To illustrate this, a patient was seen several years ago for some gastrointestinal symptoms and during the routine roentgenoscopic examination of the chest in all planes, I saw what I thought was a bulge in the transverse aorta. I tried to get a two-meter film and, though I was unable to see this shadow in either the right or left lateral positions, I reported my findings to the clinician. After careful physical examination, he was unable to find any pathology in this region. The patient, a very intelligent man, was told of this suspicion and about six months later visited an eastern clinic where he was examined by one of my colleagues who said there was a slight enlargement but not enough to worry about. I had occasion to see this man about two years later for the same clinician, and at that time, I found a well marked cylindrical aneurysm of the transverse aorta. This finding was later confirmed by my colleague in the east.

In this age of preventive medicine, the early recognition of an aneurysm is quite important for the prognosis because if it is seen early, the outlook for life is much longer and more comfortable, especially when there is a definite history of syphilis. I might say here that we have found that about 95 per cent of all aneurysms will give a positive Wassermann and, even if the reaction is not positive, the usual anti-luetic treatment is instituted.

The differential diagnosis of sacciform aneurysm and cylindrical dilatation is quite easily made, as in the sacciform type we see a definite sac which is usually pulsating; you must remember, however, that we can have a large, sacciform aneurysm without pulsation in the sac, accounted for by the clotting and organization that often takes place. I would call attention to the danger of mistaking a transmitted pulsation from the aorta to a large group of glands for an aneurysm. We have seen this reported quite often but a careful roentgenoscopic examination will eliminate this error.

In the patients with a cylindrical dilatation, we are able to see the thoracic aorta through its entire course to the diaphragm. This brings us to the consideration of the diagnosis of abdominal aneurysm. We have never been able to recognize an aneurysm below the diaphragm, by the aid of the roentgen ray no matter what the type. One patient was operated upon for abdominal tumor and a large sacciform aneurysm of the abdominal aorta was found. He was closed, and two weeks later we tried by every known means at our disposal to get some evidence

* Read at the Fifth Annual Meeting, Eastern Section, AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, Jan. 21–24, 1924.

of a tumor or a pulsation. We met with absolute failure. Pneumoperitoneum was not tried because we knew nothing about it at the time, but I would not use it even now with our perfected technique because, of all things, we do not wish to cause any additional intra-abdominal pressure.

We have seen cases with eroded vertebrae due to pressure of the tumor, with terrific abdominal pains. A diagnosis of abdominal aneurysm cannot be made on this finding alone as a new growth of the vertebrae will cause the same signs and symptoms, and it is often only at the autopsy table that the correct diagnosis is made. After careful study of all films made in many hundreds of cases we have never seen the plaques in the abdominal aorta of which we have been told. Our technique may be at fault, but we are trying in every case of thoracic examination to make an examination of the abdomen as well, and it is our opinion that calcified plaques cannot be depended upon for a diagnosis of aneurysm of the abdominal aorta.

I do not think we can very well consider aortitis in this group as I think the beginning of all cases of aneurysm of the aorta is in an infiltration and roentgenologists do not see the patients in this early stage. This is due to the fact that the patient, as a rule, does not consult the clinician until the condition has advanced beyond this early stage.

In closing, I again want to make the plea that in all cases referred to you for any chest or gastrointestinal lesion, you carefully examine the aorta in all positions with the roentgenoscope and the two-meter films at three angles. The films are made for comparison with future examinations of the patient, in order to determine the progress and to guide the prognosis.

ABSTRACT OF DISCUSSION

Dr. Baetjer (Baltimore) emphasized the difficulty encountered in differentiating aneurysm from solid tumors and stated that he relies entirely upon the roentgenoscope for the diagnosis, and uses plates only to make a permanent record of the case. He spoke also of the rarity of the recognition of aneurysm in the days before the use of the roentgen ray. Then, it was unusual to have more than one case a year, while now he can cite a period of two years when there were 118 cases of aneurysm in the out-patient department and wards.

Now that the internist has become more accurate in his methods the number found only by roentgen examination is not so great as formerly. Dr. Baetjer stated that his experience bears out Dr. Samuel's statement that roentgen examination is of little value in diagnosis of abdominal aneurysm. He believes also that fully 85 per cent of cases of aortic aneurysm have a small heart.

Dr. Hunter (Norfolk) reported a case of aneurysm to illustrate the point that pulsation is not always present in aneurysm. Organization of the clot may convert an aneurysm into a solid, non-pulsating mass.

Dr. Stewart (New York) referred to several cases of abdominal aneurysm with positive roentgen findings; all of them, however, were at the level of the diaphragm and the globular shadow could be seen extending upward into the chest.

Dr. Manges (Philadelphia) discussed the question of multiple sacs in aortic aneurysm. A majority of the pouches on the transverse portion project forward, but some project backward and that is one reason for difficulty in recognizing them clinically. He has seen a number of aneurysms in which pulsation could be felt on the posterior and not on the anterior chest wall, and in which the physical signs were definite posteriorly but not anteriorly. He reported a case in which there was present substernal thyroid and also an aneurysm of the innominate artery.

Dr. Samuel (closing). I tried to make my paper as short as I could, but it seems that I must elaborate somewhat. I agree with Dr. Baetjer that we have found very little displacement of the trachea; the tracheal tug is missing in a large percentage of these patients, and the bruit is seldom found. Aneurysmal bruit is one of the old signs that has always been relied upon, and when it is present it means something, but it usually is not present. Now the question of the organization of the clot. In the organization of the clot you get no intrinsic pulsation and are able definitely to differentiate the two shadows. I want to be thoroughly understood here, that the clinical examination by a competent clinician must go hand in hand with the roentgenologist. That is something we cannot get away from. It is very important that clinical examinations be taken into consideration in diagnosis of aneurysm, unless it is large, pulsating, and unmistakable; for the early recognition of

aneurysm the roentgenologist must work hand in hand with the clinician.

The multiple sacs that Dr. Manges spoke about we have seen in some cases. The percentage is not large. The small heart usually accompanies aneurysm in the usual type of patient outside the hardworking laborer. In the majority of cases the heart is of the small type.

We have usually found the sac anterior, but in the descending aorta it is usually posterior. The question of substernal thyroid I do not want to touch on at the present time.

The diagnosis of mediastinal tumors is practically made with the roentgenoscope with the help of the clinician. In Hodgkin's disease and allied conditions, you must take the clinical examination into consideration. The pathologist must help on the blood count, the Wassermann, etc. The case is not simply the screening or plating of a patient, and when we are satisfied with such partial examinations, we are courting failure. If we are not content to work with the clinician, we are going wrong.

METASTASIS

Malignant disease is transferred to distant structures by conveyance of tumor cells which have become detached from the parent growth. Undoubtedly, the most important avenue of dissemination in the early stages of carcinoma is furnished by the larger lymphatic vessels which join the affected organ with its regional lymph nodes, and, however distant the cancer cells may be in the later stages of the disease, it is to the lymph nodes adjacent to the primary growth that we must look for the first clinical evidence of metastasis in the great majority of instances . . .

Unfortunately, the process of cancer dissemination is an exceedingly complicated one, and while embolic invasion of adjacent lymph nodes regularly occurs, the further progress of the metastatic cells presents many problems that are far from satisfactory solution . . .

Handley maintains that cancer of the breast spreads from the primary tumor centrifugally in all directions along the plane of the deep pectoral fascia, with extensions upward into the skin and downward into the subjacent tissues. The outermost limit of this circle of dissemination is represented by "a microscopic growing edge of carcinoma cells" . . .

It would be impracticable to repeat in detail the arguments advanced by Handley in support of his theory; suffice it to say that it commends itself as a rational explanation for regional dissemination in cancer of the breast and for a large percentage of local post-operative recurrences, and at the same time serves as a rational theory for planning the radical removal of a carcinomatous breast.

From THE BREAST: ANOMALIES, DISEASES, TREATMENT *by* DEAVER and MCFARLAND, p. 494 et seq., Blakiston's, Philadelphia, 1917.

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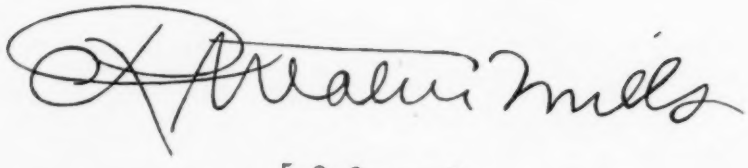

[1878-1924]

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Information of interest to all readers will be found on page vii. Lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on page preceding Editorial Section.

DR. R. WALTER MILLS

The untimely death of Dr. R. Walter Mills at forty-six years of age was announced in the JOURNAL last month. Although Dr. Mills was not a member of The American Roentgen Ray Society he was well known to our entire membership because of his frequent contributions to the programs of our meetings. This year he had applied for membership in the Society and we were looking forward to the pleasures of a closer association. His passing at this time is not only a great personal loss to his many friends, but a real loss to roentgenology and internal medicine to which he was constantly making notable contributions.

Dr. Mills was born in Webster Groves, Mo., and began his education in its public schools. In 1899 he secured his B. S. degree from the University of Illinois and in 1902 graduated in Medicine from the St. Louis University School of Medicine. After his interneship he practiced general medicine in St. Louis during 1903 and 1904. In August, 1904, he was married to Miss Irene M. Goodberlet of St. Louis and then practiced medicine in Webster Groves, Mo., from 1905 to 1911. In that year he studied under Dr. Ludwig Kast in New York and also made a trip to the clinics of Europe after which he returned to practice gastroenterology in St. Louis.

In the year 1913 Dr. Mills made another trip to Europe and for several months studied at the clinics in Berlin, Vienna, and Halle under Drs. Martin Haudek, G. Holzknecht, Siegmund Krenzfuchs, and M. Sussmann.

Upon his return to this country in the fall of 1913 he became associated as a partner with Dr. H. W. Soper in the practice of gastroenterology. He remained in this association and in this work until his death.

Dr. Mills was an indefatigable and fruitful worker and a prolific writer. During the past ten years he has made many important contributions to the literature of gastroenterology and especially of roentgenology as applied to diseases of the gastrointestinal tract.

He was a member of the following organizations:

American Gastroenterological Association, of which he was president at the time of his death.
St. Louis Society of Internal Medicine, of which he was president during the year 1923.
American Medical Association.
St. Louis Medical Society.
St. Louis Naturalist's Club.
St. Louis Anthropological Society.
American Ornithologist's Union.
The Radiological Society of North America.
Phi Delta Theta—Missouri Gamma Chapter.
Phi Delta—Alpha Zeta Chapter

Dr. Mills did notable work in roentgenology but his main interest was in clinical medicine, as a perusal of the titles of his publications listed below will show:

The *x*-ray in the diagnosis of gastric ulcer and its sequelae. *Surg., Gynec. & Obst.*, July, 1913, pp. 1–25.
Points of value in roentgenology of the gastrointestinal tract. *J. Am. M. Ass.*, Oct. 11, 1912, lxi, 1344–1348.
Observations on duodenal ulcer with special reference to its *x*-ray diagnosis. *Interstate M. J.*, xxiii, No. 4.
The relation of bodily habitus to visceral form, position, tonus and motility. Am. J. Roentgenol., 1917, iv, No. 4, 155–169.
The *x*-ray test of gastric motility. *Tr. Am. Gastro-Enterol. Ass.*, 1918, pp. 36–47.
The relation of visceral form, topography and function to the general physique with a classification of types. Pottenger's Clinical Tuberculosis, i, 335–356.
Radium treatment of cancer of the esophagus under roentgen-ray control. *J. A. Mm. Ass.*, June, 1920, 74, 1570–1576.
Syphilis of the alimentary tract and extra-abdominal viscera. *Am. J. Syphilis*, iv, No. 3, 1920.
Syphilis of the gastrointestinal tract. Nelson Loose-Leaf Living Medicine, Vol. 5, Chap. xv, pp. 311–318.
The relation of roentgenology to clinical medicine with special reference to gastroenterology. Am. J. Roentgenol., Nov., 1920, xii, No. 11, 523–531.
X-ray evidence of abdominal small intestinal states embodying an hypothesis of the transmission of gastrointestinal tension. Am. J. Roentgenol., April, 1922, ix, No. 4, 199–223.
Intestinal obstruction. Tice's Practice of Medicine, vii, 639–666.
Complete gastric motility in different types of habitus. Am. J. Roentgenol., Nov., 1922, ix, No. 11, 731–734.
Gastric motility after pyloric obstruction in infancy. *Am. J. Dis. Child.*, Nov., 1922, xxiv, 404–412.
Dentistry as a branch of medicine. *Internat. J. Orthodontia*, Nov., 1922, viii, No. 11.
Further observations on the radium treatment of cancer of the esophagus with a review of forty-four cases so treated. Am. J. Roentogenol. & Rad. Ther., Feb., 1923, x, No. 2, 148–161.
Present medical trends. Papers of the Wednesday Club of St. Louis, Jan. 24, 1923.
Direct evidence of colonic secondary changes and reactions. *Tr. Am. Gastro-Enterol. Ass.*, 1923, pp. 250–254.
The routine of a barium enema. (This paper was to have been read before the American Congress on Internal Medicine, Feb. 22, 1924.)
The red fox and the question of its importation or nativity. (Not as yet published. Read before the St. Louis Naturalist's Club, Jan., 1922.)
Medicine Bow country and its birds. (Not as yet published. Read before the St. Louis Naturalist's Club, Jan., 1923.)

ROENTGENOLOGY OR RADIOLOGY?

From time to time there has been discussion among roentgenologists and radium therapists of the nomenclature to be employed in these special fields of medicine.

The question has again arisen in connection with the proposed section in the American Medical Association which was announced in last month's issue of the Journal. The final decision rests, of course, with the House of Delegates of the American Medical Association, but presumably consideration will be given to the opinions of those members who will naturally compose the section if it is finally formed.

We are frankly of the opinion that the most suitable name is the "Section of Roentgenology and Radium Therapy."

Radiology is a term more suitable to matters pertaining to radio or wireless telegraphy than to roentgenology, and it is equally unsatisfactory as a term to include radium therapy.

Both "roentgenology" and "radium therapy" are definitive while "radiology" is a loose and ambiguous term.

Another important reason for adopting "roentgenology" is the fact that it has been accepted as the official terminology, not only of the American Roentgen Ray Society, but of the American Medical Association itself. It would not seem consistent for the latter to give to one of

its Sections a name not recognized in the nomenclature in use in its Journal.

We therefore respectfully recommend to the House of Delegates that, if final approval is given to the formation of a new section, its most appropriate designation would be the "Section of Roentgenology and Radium Therapy of the American Medical Association."

AMERICAN REGISTRY OF RADIOLOGICAL TECHNICIANS

This Board has been organized through the initiative of the Radiological Society of North American and has received the formal recognition of the American Roentgen Ray Society. The latter Society at its annual meeting in 1923 appointed one of its members, Dr. Edward S. Blaine, to serve on the Board.

The primary object of the Board as stated by its President "is to foster and to encourage the highest ideals in the vocation of Radiological Technicians. The chief value will be to the technicians themselves, but also, Radiology will be benefited by the service of technicians whose ideas are high and whose standards are well defined."

There have been misgivings on the part of some roentgenologists with regard to the official recognition of technicians, based almost entirely upon the idea that such recognition might be abused. The Board has attempted to minimize the opportunity for abuse of their licenses by any unprincipled technicians by making the following Agreement a part of the application for license: "If I receive a certificate from the American Registry of Radiological Technicians, I hereby agree to work at all times under direct medical supervision, and under no circumstances to give out written or oral diagnoses, or work independently, whether in any private office, hospital or institutional laboratory."

Attention is also given to an investigation of the character as well as the ability of the applicant for registration, and a further safeguard is the provision that the license must be renewed yearly.

The sponsors of this movement are not under the delusion that simply licensing technicians will abolish or even lessen the number of commercial laboratories, but they are convinced that proper recognition of the technicians will tend to foster in them higher ideals and that it will gradually create an organized body with a high standard of ethical conduct.

Roentgenologists are asked to cooperate in this movement by bringing the matter to the attention of the technicians employed by them.

All communications should be sent to Mr. J. R. Bruce, Executive Secretary, Guardian Life Building, St. Paul, Minn.

GENERALIZED OSTEITIS FIBROSA

We wish to call to the attention of our readers the October, 1923, issue of the Edinburgh Medical Journal. The entire number is devoted to the report of a case of generalized osteitis fibrosa, with parathyroid tumor and metastatic calcification, and includes a critical discussion of the histology of this disease and of the pathological processes underlying osseous dystrophies.

The report includes a concise history of the development of knowledge of those diseases called by the French "Osseous Dystrophies" and by the Germans "Rachitic Malacias."

The history of the authors' case is given in great detail and includes its clinical aspects, the roentgenological and laboratory findings, and the histology of various bones and of the parathyroid tumor.

In their Summary under Interpretation of 'Fundamental Histological Changes' the authors state that "Osteitis Fibrosa has been regarded by the writers as a distinct pathological entity. It is characterized by (a) bone resorption; (b) fibrous tissue substitution; and (c) new formation of bone—both reticular bone and apposition bone. Variations in the histological picture may be related to the fact that the process is observed at different stages, and to modifications in its development due to the fact that the course of the disease is not uniform and progressive, and to the further fact that remissions may occur. If remissions and healing do occur, a new architectural reconstruction of the bone takes place, under the influence of osteoblasts and osteoclasts, to meet the

mechanical and circulatory influences to which the new bone is subjected."

Under the heading "Pathogenesis-Metaplastic Malacia" the following conception of the authors is given: "----the initial change is in the activity of the bone cell and not in the stroma elements of the bone marrow. This degenerative change in the bone cell is followed secondarily by a reaction in the cell and blood-vessel content of the Haversian system, which, while inflammatory in character, appears to have a deeper significance, for it results in a reversion to an embryonic cellular tissue that is potentially metaplastic.

"The anatomical conception underlying the term 'malacia' is confirmed by the histological picture, for there is a progressive decalcification and resorption of the old bone and its replacement by an osteoid, i.e., non-calcified, tissue. The epithet 'metaplastic is justified, because the functioning cells of the Haversian system have assumed the character of an early mesenchyme cell and subsequently differentiate along several lines. This preliminary reversion and later differentiation are implied in the term 'metaplasia.' Metaplasia signifies the transformation of one tissue into another of similar morphological origin and functional character: it takes place in two phases: the one, a neoplastic, in the sense of being a new formation of cells of a less differentiated type; the other, a true metaplastic phase—the differentiation of these cells in a new direction, i.e., into a tissue genetically related. In osteitis fibrosa these two phases are represented by the reversion of the cell content of the Haversian system to embryonic cells, the great majority of which differentiate into fibroblasts and lay down fibrous tissue. New bone arises in this fibrous tissue by metaplasia from these fibroblasts, either directly (reticular bone) or through an intermediate form of osteoblasts, which are also of fibroblast descent (apposition bone). In this connection it is important to remember the specific osteogenic influence exerted on connective tissue cells by calcium salts, which may be derived from the resorbed bone."

Limitations of space in the Journal preclude the possibility of publishing an adequate abstract of this work and this brief notice is published in order that our readers may not miss a very important contribution to a subject of which our knowledge is still fragmentary and incomplete.

A copy of the issue of the Edinburgh Medical Journal containing this article may be obtained from its publishers or through the publisher of the American Journal of Roentgenology and Radium Therapy.

It is with great regret that we announce the death of Dr. Park P. Brenneman of Lancaster, Pa., on March 23, 1924.

An account of his life will be published in the next issue of the Journal.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY *visiting New York City, are invited to make the office of* THE JOURNAL (*69 East 59th Street, New York*) *their headquarters. Mail, packages or bundles may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

THE TWENTY-FIFTH ANNIVERSARY OF THE DISCOVERY OF RADIUM

The discovery of radium by the Curies was officially announced to the world in a paper read before the Academy of Sciences of Paris on December 26, 1898. The twenty-fifth anniversary of this momentous event in the progress of science was appropriately celebrated in Paris on the initiation of the Curie Foundation. The writer happened to be in Paris at the time, and was kindly invited to take part in the celebration.

The principal ceremony took place at the Sorbonne and was presided over by President Millerand. The program was as follows:

1. *La Marseillaise*, played by the band of the Republican Guard.

2. *Allocution by M. Paul Appell*, Rector of the Academy of Paris and President of the Curie Foundation.

3. *Polonaise Number* 4 (Chopin), played by the band of the Republican Guard. The sentimental appropriateness of this selection is obvious since Poland is Madame Curie's native country.

4. The presence of Professor Lorentz, who came from Leyden to take part in the ceremony, caused a change in the program. President Millerand called on the eminent Dutch physicist to speak at this point. In very good French he brought out clearly the importance of radioactivity in modern physics, its relation in the unification of chemistry and physics and the part played in the determination of atomic structure.

5. *Conference by M. Jean Perrin, "Radioactivity and Its Importance in the Universe."* Professor Perrin compared the advent of radioactivity to the conquest of fire by primitive man. He then reviewed the salient points of the discovery and of the properties of radioactive substances, emphasizing the transmutation of one element into another and mentioning the possibility of being able to do this at will in the future.

6. *Reading of the significant passages in the scientific communications of the Curies* in which the initial discoveries relative to radioactive bodies were originally announced to the Academy of Sciences. Very appropriately these excerpts were read by M. André Debierne, who was associated with the Curies in the early days of the work, and has continued his collaboration with Madame Curie. To the physicist this was the most dramatic part of the program. It gave a vivid picture of the different steps which culminated in the discovery of radium.

7. *Some Fundamental Experiments.* These were made by M. Holweck and Mlle. Irene Curie of the Curie Laboratory. They were executed most successfully, and impressed the audience greatly. The first was the discharge of a gold leaf electroscope by radium radiations, demonstrating the ionizing property of the rays. The second illustrated the random emission of alpha particles. In this experiment use was made of a radio-telephony amplifying system and loud speaker to "announce" the arrival of one alpha particle in a suitable ionization chamber. A so-called "radium clock" was then shown. The last experiment consisted in allowing radium emanation to diffuse into a glass tube coated with zinc sulfid which became phosphorescent, due to the bombardment of the alpha and beta particles.

8. *Conference by Dr. Antoine Beclère, "Radium and Medicine."* In his address Dr. Beclère outlined the rapid progress of radium therapy and the important place which it now occupies in the treatment of malignant disease. *Le Temps* of December 27 quoted the following vivid passage: "Formerly surgery was the only means to combat cancer. To-day there is a happy competition between radium and *x*-rays and the surgeon's knife. These radiations represent so many *bistouris*, or rather invisible arrows, wonderfully sharp and piercing, which riddle the whole diseased region and, without bleeding or mutilation, without injuring the skin, they kill

in a deep-seated organ the cancer cells, leaving the neighboring normal cells intact."

9. *President Millerand called upon Madame Curie to talk.* She arose amid enthusiastic applause, and was evidently deeply moved. In a very low voice she spoke of her work, paying tribute to the genius of Pierre Curie. Speaking of the discovery of Radium she said: "It was a most modest enterprise undertaken by two humble beings anxious to serve. Started in the old School of Physics where we could not find proper facilities, we were worried with difficulties which at times seemed insurmountable. We continued in spite of difficulties in order to realize an ideal which made us slaves to science. The discovery of radium was made under the most precarious conditions in a humble building that has since become legendary. Of the benefits which resulted therefrom one of us did not profit. Pierre Curie left us several years before the creation of the laboratory which bears his name. But we know that the rule of his life was to go on with his work no matter what happened, and according to his own fine expression 'to make of life a dream and of a dream a reality.' It is gratifying to know that by an unhoped-for good fortune, our discovery has helped to relieve human suffering."

10. *Address by M. Léon Bérard,* Minister of Public Instruction. M. Bérard said he could not speak of the discovery of radium as a scientist but he was happy to bring to Madame Curie the enthusiastic homage of the French Parliament. He spoke of the philosophical aspects of the great discovery, and paid tribute to science and the unselfish devotion to the search for truth of scientists such as Madame Curie.

11. *Allocution by President Millerand.* President Millerand recalled the visit which he, in the capacity of Minister of Commerce, paid to the poorly equipped laboratory in which the Curies were carrying out their pioneer work, soon after the announcement of the discovery of radium. He mentioned the profound impression which M. and Mme. Curie made upon him. In conclusion he said: "The Government of the Republic, and Parliament as faithful interpreters of the people's thoughts, have already offered Madame Curie a concrete national recompense.[1] May she receive it with the solemn homage which we pay her today as a sincere token of the universal sentiments of enthusiasm, respect and gratitude, in which she is held."

12. *A march played by the band of the Republican Guard* ended the ceremony.

One of the touching episodes of the afternoon was the presentation to Madame Curie of a winged Victory in bronze, by a representative of the student body of France. Also the Belgian students were represented by a delegation of 120 who arrived in Paris unexpectedly. They offered their tribute in flowers.

It is hardly necessary to say that the *élite* of the intellectual aristocracy of France were present *en masse.* Seats had been reserved on the stage for them and the representatives of foreign learned societies and institutions. From America, in addition to the writer, there were Professor Noyes representing the American Chemical Society, and Dr. Gendreau representing the Université de Montréal (Canada).

OFFICIAL INAUGURATION OF THE CURIE FOUNDATION

Since the Curie Foundation is practically unknown in this country, it is perhaps well to give a brief outline of its historical development. In 1912 the University of Paris and the Pasteur Institute in close cooperation founded the Radium Institute. In the years 1912–1914 two modern laboratories were built, to be devoted separately to chemical and physical researches and to biological studies of radiation. The former is an intrinsic part of the University of Paris and is directed by Madame Curie. The latter bears an analogous relation to the Pasteur Institute and is under the directorship of Dr. Cl. Regaud. The war came before the laboratories were even fully equipped and their work came to a standstill until the end of 1918. At this time, however, the work was taken up with renewed zeal, and rapid progress has been made.

[1] This refers to the yearly allowance of 40,000 francs which the Parliament had voted to Madame Curie a few days previously

Since the Pasteur Pavillion is devoted to purely scientific investigations, the need soon arose for a suitable place in proximity to the laboratory where patients could be treated properly. It was to supply this need that the Curie Foundation came into existence. It is a private organization which has undertaken to supply means to the Radium Institute for scientific research, and particularly for the therapeutic applications of radium and roentgen rays. The Foundation was recognized of public utility by official decree in May, 1921, and has enjoyed since the support of the government.

The president of the Board of Directors is M. Appell, Rector of the University of Paris; the vice-presidents are Dr. Roux, Director of the Pasteur Institute, and Madame Curie; the treasurer is Dr. Henri de Rothschild, one of the founders; the secretary is Dr. Regaud, Director of the Laboratory of Radiophysiology of the Radium Institute.

The Foundation has at the present time a dispensary adjoining the Radium Institute, a Department at the Pasteur Hospital, and a Department at the Medico-Surgical Clinic. The Dispensary consists of two two-story buildings. One, the Rothschild Pavillion, is devoted to radium therapy, and the other to roentgen therapy and diagnosis. No wards or rooms for the hospitalization of patients are available here, so that patients needing hospital care must be taken by ambulance to the two above-mentioned departments in other institutions. This is a serious disadvantage, which is felt keenly by the staff, and steps are being taken to correct it. The two buildings are very well arranged and equipped. For radium therapy 2700 mgm. of radium element are available. A considerable part of this is in solution for the preparation of emanation; the rest is used in fixed needles or tubes. The roentgen-ray equipment consists of six high voltage machines of the latest design, from which a total of eight roentgen-ray tubes can be run simultaneously.

It will be of interest to American women who donated 1 gm. of radium to Madame Curie to know that this radium is kept in the Curie Laboratory and used exclusively for experimental work by Madame Curie and her co-workers. Before she received this gift she had practically no radium, because in 1918 she had given the Curie Foundation the gram which she had prepared herself from Bohemian ores. This was in accordance with her husband's wishes, for they had agreed that they should get no personal material advantage from their discovery.

Other contributions to the supply of radium at the Curie Foundation were made by Dr. Henri de Rothschild and by the French Government.

A number of fellowships, of the value of 12,000 francs each, are available annually. They are awarded to properly qualified research workers to carry out in the laboratories of the Institute investigations relative to the biological actions of the radiations or to the radio-treatment of cancer.

Indigent patients are examined and treated gratis; to others a reasonable charge is made, payable to the Foundation. The medical staff cannot collect fees from patients treated as private patients.

The Curie Foundation had functioned for a considerable time but the formal inaguration was reserved for the morning of December 26. M. Paul Strauss, Minister of Hygiene, presided over the meeting. M. Appell spoke first. He praised particularly the Minister of Hygiene for his efforts in organizing in France a systematic fight against cancer by the establishment of regional centers, of which the Curie Foundation is the most conspicuous one. He thanked Madame Curie for her generous gift of 1 gm. of radium, and all those who had made financial contributions. Finally he praised Dr. Regaud, whose disinterested devotion to the work has made its rapid development possible. Dr. Regaud then explained the practical functioning of the Foundation.

Professor Bergonié, one of the pioneers of radiation therapy, paid a tribute to Madame Curie and recalled with emotion that it was in his laboratory in Bordeaux that she deposited her radium in September, 1914, at the time when it was feared Paris would be captured by the Germans.

M. Strauss took this occasion to thank all

those who had cooperated with him in his efforts on behalf of the cancer patient. He announced then that Parliament had voted unanimously 5,000,000 francs for the purchase of radium.

A tour of inspection through the two buildings concluded the program.

DINNER GIVEN BY DR. HENRI DE ROTHSCHILD IN HONOR OF MADAME CURIE

The Rothschild family have been interested in radium since the beginning of the work. In the early days they were influential in securing some of the Bohemian ores needed by the Curies. Dr. de Rothschild has established a fund of 200,000 francs for the Curie Foundation and has contributed 400,000 francs for the purchase of radium. The celebration of the twenty-fifth anniversary of the discovery of radium was completed in the evening by a dinner at his house, given in honor of Madame Curie. There were probably more than one hundred guests, including high government officials and the leading men of science in France. Madame Curie was very happy and cheerful the whole evening. In spite of the strenuous day she had had, she remained until a late hour.

G. Failla.

Memorial Hospital, New York City.

MEETING OF THE CENTRAL SECTION

The Central Section of The American Roentgen Ray Society held its fifth annual meeting in Indianapolis on February 23, 1924, with Dr. D. Y. Keith, of Louisville, Ky., as chairman and Dr. Raymond C. Beeler, of Indianapolis, as secretary.

There was not a large attendance at the meeting and this made it possible to make the discussions very informal and to conduct most of them in the nature of a round table. The educational value of such discussions can hardly be over-estimated and it would be well if, in our larger gatherings, this method could be used by dividing those in attendance into small groups. Dr. Case, for instance, gave one of his usual clear and comprehensive talks on "Colonic Diverticulosis" showing roentgenograms and photographs of the specimens, and Dr. Crane discussed, in a most instructive way, "The Early Diagnosis of Pulmonary Tuberculosis" pointing out the signs of the disease upon the original films.

The forenoon was devoted to diagnostic subjects and the afternoon to therapeutics. During the afternoon session Dr. D. Kahn, of Toledo, read a paper on "Treatment of Diphtheria Carriers by the Roentgen Ray." His results were generally good and in agreement with those of Dr. Hickey, published previously in this Journal.

The papers will be available to our readers through publication in the Journal at a later date.

The following officers were elected for the ensuing year:

President, Dr. B. R. Kirklin, Muncie, Ind.; 1st Vice-President, Dr. J. T. Murphy, Toledo, Ohio; 2nd Vice President Dr. George Thomas, Cleveland, Ohio. Secretary, Dr. Wm. A. Evans, Detroit, Mich.

ANNUAL MEETING OF THE ROENTGEN RAY SOCIETY

The next meeting of the American Roentgen Ray Society will be held at the New Ocean House, Swampscott, Massachusetts, on September 3, 4, 5, and 6, 1924.

Members wishing to take part in the program are requested to send the title and a brief abstract of their paper to the President-Elect, Dr. George W. Holmes, 265 Charles Street, Boston, Massachusetts, before June 15th.

THE CALDWELL LECTURER, 1924

Announcement has been received from Dr. Holmes, President-Elect of the American Roentgen Ray Society, that Dr. Goesta Forssell of Stockholm will deliver the Caldwell Lecture at the annual meeting of the American Roentgen Ray Society to be held in Boston on September 3, 4, 5 and 6.

DEPARTMENT OF TECHNIQUE

Department Editor: DAVID R. BOWEN, M.D., Pennsylvania Hospital, Philadelphia, Pa.

In this department will be published from time to time, as material is available, suggestions for improvement in technique.

ROENTGENOGRAPHIC CHEST TECHNIQUE

BY HOMER L. SAMPSON

TRUDEAU, NEW YORK

TECHNIQUE may be divided into two main subjects: first, roentgen exposure; second, the dark-room developing process.

Under the first heading there are many factors, the combination of which is preliminary to the finished result. These factors vary in value. Some are necessary and may be used in different combinations, while others are more or less factors of choice. These, arranged somewhat in the order of their importance, are the current strength, indicated in milliamperes; the exposure time, seconds; the type of tube employed; intensifying screens, used or not used; stereoscopic or single roentgenograms; use of films or plates; use of the Potter-Bucky diaphragm; the phase of respiration in which the exposure is made; the position of the patient; the direction of tube shift; and diaphragming.

Any recommended technique reminds one of the "radio bug" who thinks his "hookup" is the best. It is probably the best for him because he has learned how to handle it. So it is with roentgen techniques; there are many, and, in the hands of the respective operators, produce good results. The important factors to bear in mind are that the finished film or plate should be full of detail, of moderate contrast and without objectionable distortion. Exposures beyond four or five seconds make it difficult to obtain a film in which the patient has not moved or breathed. However, good results can be obtained with three seconds, or less; which would mean less than seven seconds for stereos. The writer has found it a distinct advantage to keep all factors constant except the time of exposure, which is varied according to the depth of the chest. The writer wishes to emphasize the value of selecting only one of the exposure factors as a variable. The prime object of "locking" (so to speak) all the factors but one makes it possible to obtain uniform results in different subjects, and in the same subject at a later date, this latter feature

FIG. 1. Calipering or measuring the chest. The measurement is made at about the level of the third rib anteriorly and the exposure based on this.

being very valuable in comparative chest work.

The patient is centered over a vertical line. In the illustrated changer the supporting chain furnishes this guide. In height, the tube is centered at about the angle of the scapula and the tube shifted from

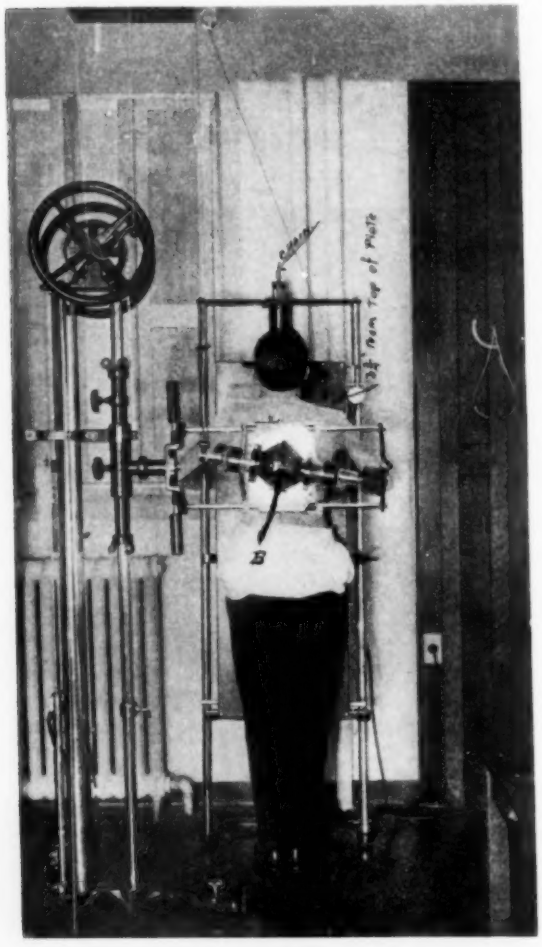

FIG. 2. The line A is about level with the apex of the lung: The patient is centered laterally with the chain on the plate changer. The tube for the first film is about 1¼ in. above the center of the film, shifting to 1¼ in. below center. The lower angle of the scapula is a trifle lower than the middle of the film. The relation of tube, patient and film is judged from sighting point B.

above downward 1⅛ inches, above and below this point. With the gravity shift there is practically no movement of the tube after the shift has been made; and this gives, in the resulting films, the advantage of looking around the ribs, so to speak. The upright position is more comfortable for the patient and attended with less nervousness. The patient's hands are reached well around the changer to remove the scapula shadows from the lung field. This position also helps to eliminate movement.

STANDARDIZATION

The value of standardized work of this character is fully demonstrated. Knowing the spark-gap, milliamperage, distance, and the time of development before hand, removes these from the field of calculation; the time of exposure being the only variable. On a basis of such reckoning, we should be able to produce the same quality of film regardless of the interval of time. Though this ideal is not always reached, very uniform results are obtained by this method.

After the films have been made, proper photographic handling is the next step. Too much emphasis cannot be placed upon proper development, as many a perfectly exposed film has been spoiled in the dark room. A properly exposed film will come out all right if the time of development at the given temperature is followed. If you know the film was over-exposed, shorten the developing time, and vice versa; remembering that you cannot produce a shadow on an underexposed film, where it never existed. In consequence of this, it is usually safer to overexpose rather than underexpose. Standardizing the work in the dark room, i.e., developing the proper length of time for a given temperature, is a good check on the work done in the laboratory and almost always reveals faults in exposure.

By constantly watching and checking up errors the variable factor can be handled satisfactorily.

The following technique has been very satisfactory in our chest work.

(C denotes Constants)

C5–5¼″	Spark gap measured at the tube, between moderately sharp points, registering on a sphere gap at 65 k.v. app.
C30 ma.	Current.
C30″	Tube-film distance.

Time	Varies according to depth of chest, as follows:

Depth (cm.)	Time (sec.)
12	.6
13	.7
14	.8
15	1.
16	1.1
17	1.3
18	1.4
19	1.6
20	1.7
21	1.9
22	2.1
23	2.4
24	2.6
25	3.
26	3.4
27	4.

C Tube	30 ma. radiator type
C Films	Duplitized super-speed, without intensifying screens. (With screens 1/8 to 1/6 the time.)

Development—Eastman powders. 65° temperature 6 minutes, increasing the time as the developer weakens from use; also increasing the time for a cooler solution; decreasing for a warmer. Limits of temperature of solution, 60° to 70°.

The constants or standards and variable can be worked out for different parts of the body.

Editor's Note: Mr. Sampson has not mentioned a metal marker permanently fastened to his stereo film changer, in such a manner that its shadow is left upon an upper corner of the first film of each pair exposed. The corner so marked serves as an indicator for correctly placing the pair in the stereoscope. If, for instance, the marker is over the upper right corner of the first film its shadow will belong in the upper back corner of the left hand view box. A real time saver.

D. R. B.

SOME CAUSES OF POOR CONTACT BETWEEN INTENSIFYING SCREENS AND FILM

BY R. B. WILSEY

ROCHESTER, NEW YORK

IT is well known that firm contact between intensifying screens and film is essential for the best roentgenographic definition. In double screen technique, nearly the whole photographic effect is due to the fluorescent light from the screens, and any lack of contact between the fluorescent image and the film is sure to result in blurred outline in the roentgenograph. In the roentgenography of thick parts, the loss in definition due to the inherent limitations of the screens is, for most types of screens, negligible in comparison with the effects of poor contact, scattered radiation, and the effect of size of focal spot combined with the distance of the part rayed from the film.

Experiments with a new method of testing screen contact have shown some of the causes of poor contact, and indicate the ways by which good contact may be obtained. In this test a screen is ruled with cross lines; a cleanable screen may be ruled with a grease pencil and the lines washed off afterward, or an old screen may be ruled with ink.[1] A flash exposure made with such a screen shows the rulings as clear lines on a dark background, the sharpness of the lines depending on the closeness of the contact between screen and film.

Figure 1 shows such a test made in a cassette having a rigid back lined with a thin hard felt. The cassette had been in use for several years and the aluminum front had become permanently bulged out. The test shows clearly the effect of this upon the contact between screen and film; the contact is good at the edges of the film but very poor over the central area. The padding on the cover of the cassette was then reinforced with a layer of thick soft felt and the test in Figure 2 was obtained; the contact appears quite good over the whole area of the film.

Similar results were obtained in other tests. A new cassette of another type, with rigid back and thin felt padding, gave better contact than the first cassette, but the test also showed an irregular area of poor contact in the center. Several cassettes with thick felt padding on the cover all gave good contact over the whole area of the film regardless of whether the cover was rigid or slightly flexible. Evidently the thick layer of felt serves to compensate for the differences in the surfaces of the front

[1] This test was suggested to the writer by Mr. F. C. Martin of the Medical Division, Eastman Kodak Company.

face of the cassette and the cover, so that sufficient pressure is exerted over each portion of the screen to give good contact everywhere. An air cushion should give completely uniform pressure over the whole cassette, regardless of irregularities in either the front face or the cover.

The usual practice in cassette design is to make the cover rigid, whereas the thin aluminum face of the cassette cannot be

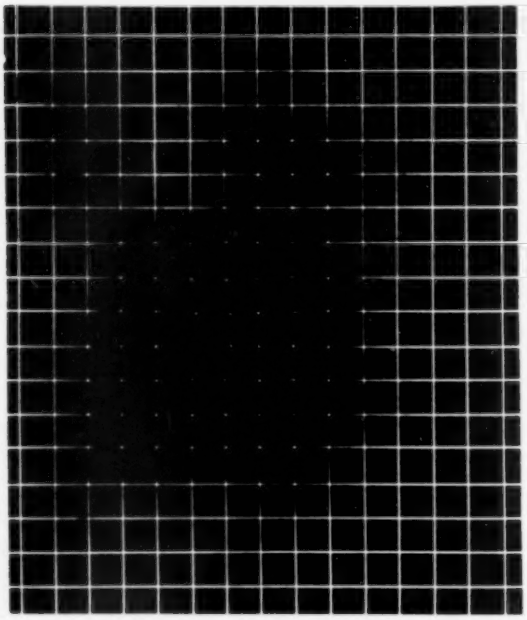

FIG. 1. Test of contact between intensifying screen and film in cassette with rigid back padded with thin hard felt. The test shows poor contact in central area.

made rigid no matter how tightly it is stretched over the frame, with such a cassette the contact depends largely on the character of the padding on the cover. It would seem more logical to attempt to make a cassette cover that under the pressure of the springs would assume nearly the same form as the front face, and use a layer of felt or other padding sufficient to compensate for the small irregularities between the two surfaces. In addition to being slightly flexible, the cover might possibly be formed with a slightly convex surface; the exact form of surface and degree of flexibility would, of course, have to be determined by experiment.

For convenience in using the cassette, the cover should preferably be hinged permanently to the cassette in a manner that allows for variations in the thicknesses

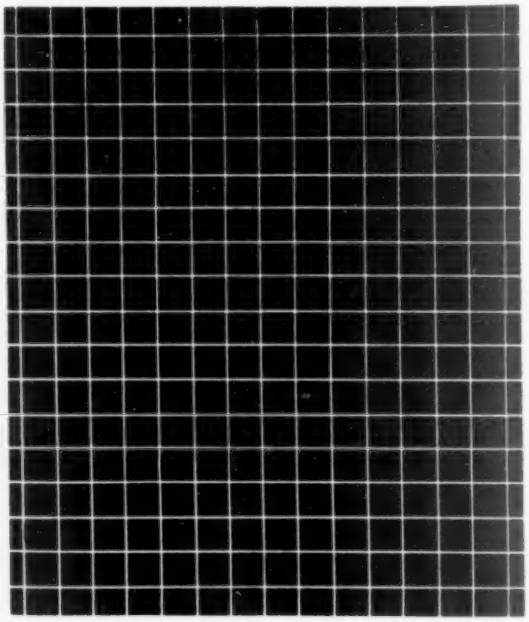

FIG. 2. Contact test with same cassette; the padding on the cover has been reinforced with a layer of thick soft felt. The test shows good contact over the whole film.

of screens; in loading the cassette, the screens and film should fall automatically into the correct position without the necessity of adjusting them; for this reason, the

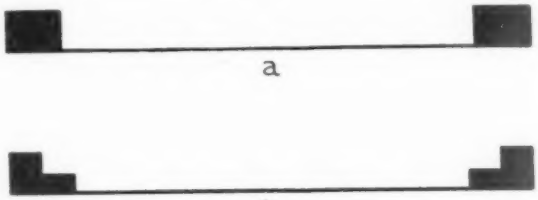

FIG. 3. For convenience in loading, the cassette should have straight sides as illustrated in cross section at (a). The ledge shown at (b) gives difficulty in adjusting screens in correct position.

straight sides as illustrated in Figure 3a are preferable to the ledge, as shown in Figure 3b. In addition, the cassette should be made as light and thin as is consistent with substantial construction.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE EFFECTS OF RADIUM UPON LIVING TISSUES. By Sidney Forsdike, M.D., B. S. Lond., F. R. C. S. Eng. Surgeon to Outpatients, Hospital for Women, Soho Square; Gynecological Surgeon to the Kensington and Chelsea General Hospital. Price $2.00. Pages 72. Paul B. Hoeber, Inc., New York, 1923.

The seventy-two pages of this volume cover very adequately the history, animal experiments, clinical application, and conclude with the statement that "Radium has won its spurs in clinical medicine by virtue of its effect upon malignant tumors."

The author's query "Are we to continue to treat only inoperable cases?" is answered by his plea for radium treatment in early cancer of the cervix.

The concluding chapter is devoted to "The Treatment of Severe and Persistent Uterine Hemorrhage by Radium, with a Report of 45 Cases" which constituted a paper read before the section of Obstetrics and Gynecology of the Royal Society of Medicine in March, 1923.

His reasons for employing radium to the exclusion of the roentgen ray in such cases will not be accepted by the well-informed roentgenologist. It would be difficult to find one who would admit having produced "ulceration of the bowel and superficial burns" or who devoted anything like "three to four hours on two succeeding days, repeated at intervals of twenty-one days on four to six occasions" to accomplish a cure in uterine bleeding. His remaining objections to the roentgen ray are likewise not well founded.

Generally speaking, however, the book constitutes a satisfying epitome of the subject covered by the title.

ATLAS TYPISCHER RÖNTGENBILDER VOM NORMALEN MENSCHEN. (Atlas of typical roentgenograms of the normal individual.) Lehmann's med. Atlanten. Band V. 4th Ed. Bound. Price, $4.70. J. F. Lehmann, München., 1923.

This valuable atlas, after a lapse of five years, has now been published in a new edition. As an excellent book for study, it may be recommended to beginners in roentgen diagnosis; and experienced roentgenologists can consult it with profit because of its value as a reference work. New illustrations have been introduced, and some of the former ones replaced. (It seems to the reviewer that Tables 24 and 25 might have been revised.) The picture of the growing bony system, and in the field of vertebral spinal system, the sketches of oblique exposure all deserve recommendation. The ossification tables are valuable for ready reference. It may therefore be said that this volume is of value as a reference work and has the additional virtue of interesting presentation.

G. F. HAENISCH.

BOOKS RECEIVED

SCIENTIFIC REJUVENATION WITHOUT OPERATION. By H. H. Rubin, M.D. 64 pp. New York: Medical Science Publishing Co., 1923.

RADIUM, X-RAYS AND THE LIVING CELL. By Hector A. Colwell, M.D. (Lond.) D. P. H. (Oxfd.) and Sidney Russ, D. Sc. (Lond.), F. Inst. P. 365 pp. London: G. Bell and Sons, Ltd., 1924.

THE BIOLOGY OF THE INTERNAL SECRETIONS. By Francis X. Dercum, M.D., Ph. D. Price $2.75. 241 pp. Philadelphia and London: W. B. Saunders Company, 1924.

RADIUM REPORT OF THE MEMORIAL HOSPITAL, New York. (Second Series, 1923.) Price $5.00. 305 pages, with 55 illustrations. New York: Paul B. Hoeber, Inc., 1924.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

GUNDERMANN. On the treatment of peripheral roentgen ulcers by periarterial sympathectomy. *Beitr. z. klin. Chir.*, 1923, cxxix, 231.

Ten per cent NaCl solution compresses, ointment bandages and caseosan injections failed to overcome pain and stiffness of the hand from roentgen ulcer. Periarterial sympathectomy of the brachial artery was made. The next day the hand could be moved, the ulcer diminished and the patient who had been staying in bed on account of pain desired to get up. After five or six months the ulcer was covered over, and epithelialized.

Another case of roentgen ulcer at the right elbow was cured by dissecting loose the arteria and vena axillaris for 6 to 8 cm. from their sheaths. While this was being done several branches from the medianus and the ulnaris which entered the sheath were severed. Two hours after the operation the hand felt much warmer and the pulse was stronger. The pain was gone by evening.

Periarterial sympathectomy the author contends will have a prominent place in future dealings with roentgen ulcers. He does not attempt to find the explanation of the process causing the improvement, and makes only a few conjectures which he however does not consider conclusive.

HOERNICKE, C. B. Roentgen treatment of bone and joint tuberculosis. *München. med. Wchnschr.*, 1923, lxx, 943.

Iselin proposed maximum radiation for bone and articular tuberculosis. Later he used less than the erythema dose for fear of ulceration. Generally one-third of the cutaneous erythema dose is used. This is a dose which, after eight days, causes slight reddening of the radiated skin, and brown discoloration after four weeks. Where abscess or fistula exist, small doses must be given. Some fibrous forms cannot be influenced. They must be treated with up to 60 per cent of the cutaneous erythema dose. Within six weeks one will increase up to a maximum of one cutaneous erythema dose. After three treatments an intermission of three months should be made. Aluminum, copper, or zinc are used according to the depth of the focus, and the type of the skin. Simultaneously, general orthopedic treatment should be given, particularly where other tuberculous foci exist in the body. Where splints have to be resorted to on the lower extremities, they ought to be changed every six weeks. Tuberculin sensibilization of the focus may be of good effect, as it may cause hyperemia.

Surgery cannot be entirely replaced by roentgen ray in bony and joint tuberculosis.

The customary doses have no influence upon healthy bone and cartilage, while tuberculous granulations are hypersensitive to roentgen rays. If granulations surround a bony lesion, they will be sequestered out. A cavity with sharp borders will remain. It will fill in very slowly with bony tissue.

HOLFELDER, HANS. Experiences with roentgen therapy for malignant tumors in Schmieden's Clinic. *Strahlentherapie*, 1923, xv, 715.

Indications for the roentgen treatment of tumors cannot be generally given because in each case the type of tumor and other circumstances must be taken into consideration. In Schmieden's Clinic every operable carcinoma with very few exceptions is operated upon and subsequently treated by roentgen rays prophylactically, unless the patient declines it, or the operator has some scruple. Aside from this prophylactic postoperative radiation, a preoperative intense radiation has gained more and more ground. As far as possible, all inoperable carcinomata and all inoperable recurring tumors are radiated. In some cases a clinical cure can be affected, in others a possibility for operation can be obtained. In other instances, the danger of hemorrhage will be diminished, and also pain and putrefaction, and the danger of further metastases. In facial carcinomata where the operation and transplantations have yielded unsatisfactory cosmetic results, roentgen rays will often correct the effect. The great majority of sarcomata are treated with roentgen rays, especially where operation would produce intense disfigurement. One must not be misled by a proliferation of growth immediately subsequent to radiation. As the indications of this clinic are closely drawn, the material is composed mainly of inoperable cases, or of prophylactically treated patients. During the time of November, 1919, until November, 1921, 43 cases of operable mammary carcinoma were radiated prophylactically after operation. Thirty of these patients are now alive, and show no recurrence. This amounts to 70 per cent. One patient died six months after operation from pneumonia, and no carcinoma was found at postmortem examination. Twelve cases had recurrence or metastases. Nine have died. Recurrence and metastasis occurred

within fourteen months, on an average, or as a maximum, twenty months.

During the same period, 51 cases of rectal carcinoma were treated. Fifty-seven per cent of these were inoperable. Five of these became operable by using roentgen rays on the anus. Twenty-nine and one-half per cent are still alive, and better, while other operative statistics give only 10 to 12 per cent with three years' freedom from recurrence. Thirty-two cases died in consequence of this disease.

In gastric carcinoma the stage of experiment has not yet been passed, either in a curative or in a prophylactic sense. It is necessary to eliminate accessory damages before applying roentgen rays in stomach neoplasms. Somewhat of an improvement was arrived at two and one-half years ago, by avoiding the adrenals. Of 12 cases on whom a radical operation was performed, and who were radiated prophylactically after operation, three beyond doubt are still living. However, the time of observation is too short to permit any conclusions. Among 5, where operation was not radical, and radiation employed after operation, only 1 is definitely known to be still living without discomfort. Among the 24 inoperable cases of gastric carcinoma, where roentgen rays were applied therapeutically, none is living without discomfort. All that can be said about radiation of gastric carcinoma is that it is a method which may be used in sensitive patients, without much discomfort.

Seven cases of mediastinal tumors are reported. Four of them died, and 2 are much improved and still living, and 1 of them is cured, and has no discomfort. Among 6 cases of lymphogranulomatosis, 5 showed good temporary results for a year; 4 of them, however, have died, and 2 are still being treated for recurrence.

KLARE, K. and DEHOFF, E. D'Espine's sign and roentgenogram. *Ztschr. f. Tuberkulose*, 1923, xxxviii, 260.

One of the most valuable diagnostic aids is d'Espine's sign—spinal auscultation of the whispered voice. It has been used by the author in 400 cases simultaneously with roentgenograms in bronchial glandular tuberculosis. Bronchophony is marked and masses of intumescent shadows in the hilus were found in 130 cases, or 32.5 per cent. A weak or no whisper with old calcareous foci and negative roentgenograms, that is such that did not show the usual signs of active tuberculosis in 204 cases, or 51 per cent. In 9.3 per cent the symptoms could not be clearly interpreted. In 7.2 per cent there was no accord between d'Espine's sign and the roentgenogram.

LIND, S. C., and BARDWELL. The coloring of the diamond by radiation. *J. Frank. Inst.*, Oct., 1923, excvi, 521–528.

The diamond is colored green, when exposed to the direct radiation from radium, which color is removed by heating to 500° C.

Recutting the stone removes the color, perhaps from the heat generated in the polishing; the carbon spots produced are also removed by heat.

DR. LOMON. Method permitting the taking of successive roentgenograms in the course of, and subject to the control of roentgenoscopy. *Bull. et. mem. de la Soc. de Radiol. Med. de France*, July, 1923, 210.

The method of which this communication is the object permits in the course of a roentgenoscopy made with the aid of a screen of normal dimension the taking of roentgenograms under the control of roentgenoscopy. These can be as numerous as may be desired. Roentgenoscopy is not subjected to any modification of technique from the employment of this apparatus.

The apparatus has the appearance of an ordinary roentgenoscope about 40 × 40, and is not sensibly heavier or thicker than the usual screen. The back part of the screen has a double bottom perfectly permeable to the roentgen ray with the exception of a plaque 13 × 18 (placed in part in the length of frame), which is doubled with lead.

The free space reserved by the double bottom permits an aluminum carrier, mounted on an axle and controlled by a lever, to be placed by the axle of a lever in the upper left region or in the central part of a roentgenoscope An opening in the frame of the apparatus permits to slide into the chassis a special film carrier. These film carrier-cassettes (aluminum) are thin, presenting no external obstructions and take the films with or without the screen, assuring a uniform pressure, depending upon the thickness of the support chosen.

MILANI, E. Clinical and roentgenological observations on the so-called hypertrophic pulmonary osteoarthopathies in the tuberculous. *Rass. int. di clin. e ter.*, 1923, iv, 377.

Drumstick fingers were formerly considered a sign of pulmonary trouble only, but it was later found that patients suffering from chronic heart disease, as well as those with subclavian aortic aneurysm, and mediastinal granulomatosis, spinal vertebral disease, carcinoma of the esophagus, chronic pyelonephritis, and icterus presented them likewise. They are also found in bronchitis, bronchiectasis, tuberculosis, pulmonary cancer, and emphysema.

Often the distal bones are enlarged in pulmonary disease. A few authors who studied the nails and finger-tips, roentgenologically, however, found them normal in size.

The author studied 450 patients who had Koch bacillus. He found 51, that is, 11.3 per cent digital deformities. In 10 out of 17 patients with these deformed finger-tips, cavities were found in the lungs, clinically and roentgenologically. These changes in the fingers were not as frequent in broncho-alveolar conditions and in sclerosis. (Eight cases out of two hundred eleven.) In the ulcerative forms, 24 were found among 108. The author considers these changes as existing more in the soft parts, and that the phalangeal development is somewhat changed.

MOORHEAD, T. G. Remarks on hyperthyroidism. *Irish J. Med. Sc.*, 5th series, No. 15, May, 1923, 107–118.

In cases under medical treatment, the gain in weight is the first and most important result. When treatment is successful the weight soon steadies, and in a few weeks begins to go up. Till an increase is registered, one cannot feel that progress is being made.

Secondly, there is a diminution of the tachycardia. In the process of recovery, tremor, sweating and other symptoms lessen pari passu with the gain in weight.

The treatment adopted is as follows:

1. The patient must go to a nursery home for the first month. The work cannot be done in the home of the individual.

2. During the first week, the patient remains rigidly in bed. An ice bag is applied to the thyroid gland at least two hours daily. Diet largely vegetarian. Sedatives at night, if required. Very few visitors allowed. Quinine bromide, 5 grains, given three times a day, and any local septic foci eliminated.

3. During the next three weeks, the same regime is followed, the patient receiving, in addition, a roentgen-ray treatment over the thyroid and thymus regions. The dosage is for the roentgen-ray expert, and none but experts should be consulted in any case.

4. At the end of the month, the patient can return home for a month, going easily, not getting up until after lunch, and taking only short walks.

5. After this month at home, a second three weeks roentgen-ray course is carried out, this being best done in the Nursing Home.

At the end of the first three weeks, the patient is as a rule, more comfortable. When the treatment is over, there is an enormous gain all around, and at the end of six months from the beginning of treatment, the patient should be perfectly well. The goiter, as a rule, becomes hard and fibrous; and the process of fibrosis may continue for long after the treatment is finished. The results are as good as those of surgery without its dangers. "Hale White, and other writers have emphasized the fact, that operation only too frequently is not a certain cure—and inasmuch as it is uncertain and is not safe, I prefer the course that is uncertain, but safe."

MURPHY, JAS. B., MAISIN, JOS., and STURNS, E. Local resistance to spontaneous mouse cancer induced by *X*-rays. *J. Exper. M.*, Nov., 1923, 645–653.

Careful experiments indicate that the lethal doses for transplanted mouse and rat tumors, are rarely, if ever, within the therapeutic dose for man. On the other hand, certain forms of cancer are cured by roentgen rays.

The fact that cancer cells are not easily killed by roentgen ray and yet cancer may be cured by this agent, requires examination if it is to be developed into a more effective form of treatment.

It has been shown that an erythema dose of roentgen ray renders the area highly resistant to inoculated cancer. As transplantable tumors were used for these experiments no general deduction can be drawn concerning the behavior of spontaneous disease.

In experiment one, a mouse with a spontaneous mammary cancer, was operated on with removal of the tumor. With the tumor removed an area on the left flank, 12 × 15 mm., was exposed to an erythema dose of roentgen ray, with the following factors; Spark-gap, 3 in.; ma. 10; distance 6 in.; time, 2½ min.

Immediately after this treatment a small bit of the original cancer was reinoculated intracutaneously in the roentgen-rayed area, and a like graft in the right flank, which had been protected from the roentgen ray. Among forty mice, with various types and stages of mammary tumors, subjected to this treatment, the inoculated graft in the irradiated region failed to grow in 35, or 71.4 per cent, while the graft in the untreated area, failed in only 8, or 16.4 per cent. Those that grew in the irradiated area, grew much more slowly than those in the non-irradiated area, so that on the death of the animal it was not more than a fraction of the size of the other tumors.

From these experiments it is evident that the local immunizing effect of the roentgen ray is just as effective against autografts of spontaneous tumors as it is against transplants of transplantable tumors.

Will the conditions induced by roentgen rays, be sufficiently unfavorable to influence an established tumor in the skin?

Autografts from spontaneous cancers established and growing in the skin, disappeared in 76 per cent of animals after tumors and surrounding tissue had been exposed to an erythema dose of roentgen ray, whereas other autografts of similar derivation which had received a like dose outside of the body, and had been implanted in the same animals, grew progressively in 96 per cent of instances. That this was not due to a greater susceptibility of the cancer cells, roentgen rayed in situ, was shown by the fact that tumors treated in situ with roentgen ray and then replanted in an unrayed location, on the same animal, grew actively. Evidently, the ray had done no direct damage to the cancer cells.

PEPPER, G. E. Deep *x*-ray therapy, in gynecology. *Irish J. of Med. Sc.*, 5th Series, No. 14, April, 1923, 67–78.

Tube hardness is best found by a Benoist penetrometer, and no tube of less than 9 Benoist units should be used for deep therapy. The harder the tube, the more penetrating the ray and the less the effect on the skin.

The depth dose is measured by a water phantom, as water and the tissues have approximately the same absorbing power.

It is most important to allow between fields, at least 3 cm. to avoid overlapping doses on the skin.

Susceptibility to Irradiation. The skin of the neck and shoulders is the most sensitive, then the abdomen, upper legs and back. This difference does not exceed 10 to 15 per cent. Light haired people are about the same degree, more sensitive than black haired.

Patients suffering from nephritis or syphilis, may be 50 per cent more sensitive than those free from these diseases.

Leucopenia must be carefully watched for. The blood recovers its composition in three weeks after a sterilization dose, and six weeks after a carcinoma dose, and is used as an index of the results of treatment. Treatment must not be resumed until the blood has returned to normal.

The action is a short distance one, and varies greatly with distance, an intensity at 1 cm. being equal to 1; at 4 cm., it becomes .063 or only about 5 per cent of the initial energy. With roentgen-ray action, at a distance from 50 to 100 cm., it becomes possible to apply doses of fairly equal strength, on the surface and 5 cm. below it.

It is suggested that the roentgen ray acts by action on lecithin causing it to split and liberate cholin which poisons and kills the cells, the roentgen ray freeing the cholin in the cell itself. Malignant cells contain a higher percentage of lecithin than healthy cells.

Malignant cells have from 5.5 to 8 per cent of lecithin.

Testicles have 7.3 per cent lecithin.

Liver has 4.8 per cent lecithin.

Muscle has 2.3 per cent lecithin.

This may explain the so-called selective action.

NEUDA, P., and REDLICH, F. On the part played by the liver in generalized roentgen injuries. *Wien. klin. Wchnschr.*, 1923, xxxvi, 773.

Every roentgen radiation causes some change in the chlorin metabolism which consists in the transmission of chlorin into the blood from the tissues and from there through the kidney out of the body. If this course is pursued regularly, no severe symptoms will follow radiation. This metabolistic function, however, constitutes a slight roentgen injury. If the chlorin, however, does not pass into the urine, a lowering of the chlorin mirror in the blood is the consequence. This is seen in cases where the liver is either originally diseased, or where the hepatic function is insufficient. It may be seen in cases where the liver cannot meet the requirements of regulation following radiation. This is a relative insufficiency, which has been found increased where lack of salt exists. Severe roentgen injury will be the consequence.

The authors' experiments show that the roentgen rays have a definite effect on albumin, which is associated with the change in the chlorin metabolism of the body. In normal patients, especially in those with a healthy hepatic function, no disturbances arise. Superfluous chlorin is eliminated by the kidney. If the regulation does not take place a disturbance of the physico-chemical equilibrium occurs in the blood colloid from causes so far unknown. The leucocytes diminish, precipitately, and the blood pressure drops. The time for coagulation is changed, and the refractometric index and a lowering of the chlorin mirror in the blood take place.

PERTHES, J. On the biological and clinical effect of roentgen therapy in surgical cancer. *Strahlentherapie*, 1923, xv, 695.

There are a number of different conceptions of the effect of roentgen rays on cancerous tissue; (1) that they kill the cancer cells, acting much like a cautery or a corrosive, with the difference that the healthy surrounding tissue remains unaffected; (2) that the car-

cinoma cells are not killed, but their vitality lowered so that they may be overcome by the body resistance. These two theories accept a damage to the tumor cells by the roentgen rays. The adherents to these theories use doses which destroy, they cannot use lower doses than the carcinoma dose.

Two other theories accept an irritating or a stimulating affect which increases the defensive power of the organism. Stephan and Theilhaber speak of a local irritation which increases the defensive action of the surrounding tissues. The fourth theory reasons that a stimulation at a point distant from the tumor will mobilize vital forces in the body to overcome carcinoma growth. (Caspari, Opitz, Fraenkel.) The last author recommends radiation of the hypophysis.

It has, however, been found that the roentgen rays have a destructive influence on the entire organism as well as on the carcinoma cells. Radiation made after operation upon the mammary glands has been found to reduce the body resistance towards new growing carcinoma. Proofs of this were given by American and English investigators in animal experiment (Murphy, Nakahara, etc.). The immunity in rats and mice towards rat carcinoma decreased after roentgen application.

Cases of carcinoma which were healed were treated locally. It is evidently necessary that the cancer cell be damaged in order to derive a curative effect from roentgen rays. Specimens show that carcinoma cells are injured, and that their nuclei more especially degenerate under the influence of the rays. Evidently, they exert detrimental influence upon cell division.

Lacassagne found that twenty-four hours after the application of radium in uterine carcinoma only atypical karyokinesis was seen. In dog carcinoma roentgen rays produced atypical cell division within twenty-two hours. Four days later there was generalized extensive disturbance in the mechanism of cell division.

The best effects in circumscribed carcinoma are undoubtedly derived from giving large doses in one session.

If the roentgen rays cause a defensive action in the growth of the connective tissue, the course to pursue would be to give irritative doses. In that case the smaller doses would be more effective than the large ones, which destroy the cells. The repeated doses would be more effective than the large single dose. Caspari, Opitz, Kok, and Vorländer have made experiments which showed that surviving carcinoma cells in mouse tumor are not killed outside the body, and that their inoculability is not lost, even where large roentgen doses are used. Wood and Prime, however, found that mouse tumor cells were killed in vitro with four cutaneous erythema doses. The conclusion is reached that the effect of the roentgen rays must after all be considered as a damage done to the carcinoma cells, which are subsequently fully destroyed by the defensive forces of the body. Therefore, roentgen therapy must have the aim of damaging the tumor cells, and preserving the defensive forces of the organism. Not only the connective tissue around the cancer focus, but also the defensive bodies in the blood, and in the entire organism, must be preserved. Protracted intense radiation of large parts of the body damage the circulating blood. Often the bad effects of intense radiation after operation for mammary carcinoma will cause exhaustion of the patient. This is a sign of inadequate application.

Among 17 operable cases treated by the author, and who would not be operated, 15 were primarily healed; 3 showed recurrence; the total of cases which were not healed, was 5. The author estimates the probability of permanent cure as existing in less than 70.6 per cent.

Bier reports a case, on the other hand, where a woman, aged sixty-four, refused operation for a scirrhous mammary carcinoma, and who was cured by three series of six roentgen radiations. She remained well for six years, when she died of paralysis. Several other authors have reported on cures which lasted for several years. Berger and v. Seuffert found cases which remained cured for five years, and Berger had a lasting cure in 21.4 per cent. In one case of carcinoma of the tongue, in a woman, aged sixty-one, complete cure was effected. Radium and roentgen rays were used simultaneously and after four years no recurrence had been observed.